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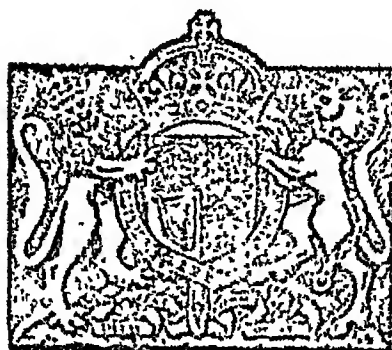
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# FOREST RESEARCH IN INDIA

*1936-37*

PART II—PROVINCIAL REPORTS



DELHI: MANAGER OF PUBLICATIONS  
1938

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*(This report has been printed on mixed species of bamboo paper made at the Forest Research Institute, Dehra Dun.)*

# FOREST RESEARCH IN INDIA, 1936-37.

## PART II.—PROVINCIAL REPORTS.

### CHAPTER I.

#### GENERAL.

The research work carried on in provinces has made steady progress during the year. Silviculture receives most attention but increasing efforts are being made towards a fuller and better utilisation of the products of the forest. The appointment of special officers on utilisation has been of distinct benefit to trade. The following attempts to summarise the chief items of interest in the provincial reports.

#### *Silviculture.*

The all India teak seed experiment continues, several of the plantations have been thinned and made into sample plots. Unfortunately all the work done at Dehra Dun has been destroyed by frost which appears to be increasing in intensity in Northern India.

*Assam.*—Progress continues to be made in standardising methods of regenerating the evergreens.

The natural regeneration of sal in Kamrup is becoming annually more and more successful but success is dependant on rain-wooding, an operation which is not everywhere practicable. Regeneration in Kachhugoon is still in the experimental stage.

*Bengal.*—The problem of the natural regeneration of sal remains entirely unsolved. Although the technique of sal plantations is well understood it is now obvious that the normal regeneration area cannot be worked up to under this system and that natural regeneration must be undertaken especially in the Bhabar

tract. Much interest has lately been taken in Kamrup methods and experiments on these lines are in progress. Much work has also been done on the natural and artificial regeneration of evergreens in Chittagong and the results are encouraging. The notching of *Dipterocarpus turbinatus* under high shade has proved very successful on a divisional scale at a low cost. In Darjeeling, *Cupressus torulosa*, *Cupressus cashmeriana* and *Juniperus virginiana* show much promise. A valuable little book on thinning in plantations by Mr. C. K. Homfray was published during the year.

*Bihar.*—The most interesting silvicultural experiment being carried out is the large scale contour trenching of dry hill sal forest in Chota Nagpur. There has been considerable correspondence and some controversy on this subject in the pages of the *Indian Forester*. The ultimate outcome of this experiment will be watched with interest. An experiment in controlled annual burning of sal has now been carried out in Saranda since 1923 and the results clearly show the benefits of complete fire protection in this type of sal forest. The plot burnt annually is in very poor condition, there is a characteristic barrenness of soil and several sal poles are top dry and have produced epicormic branches.

*Bombay.*—The thinning of teak plantations appears to be the great silvicultural problem confronting the staff. It is well known that the early and continued thinning of teak plantations is essential and steps to carry out this measure as a routine operation are very necessary not only in Bombay but in several other provinces. Some interesting observations on the growth of sandal are also in progress.

*Burma.*—Burma reports that the natural regeneration experiments on *Dipterocarpus tuberculatus* in East Katha division indicate that fire protection, though beneficial to the growth of regeneration, is not essential for establishment. *Pentacme suavis*, however, needs fire protection but has not much chance to hold its own against the former species where growing together. The effect of clear felling over existing natural regeneration of *D. tuberculatus* in Zigon division has shown a steady progress towards establishment of plants.

Experiments on stump-planting *versus* direct sowing or entire transplanting of teak confirmed previous years' results that the advantage of planting stumps begins to be lost in the third year. As regards early (pre-monsoon) planting of stumps, the indications have been that it would be unsafe to recommend very early planting in areas with less than 100" annual rainfall, though, if protected with a covering of loose earth, they can probably be planted

in areas with rainfall as low as 60". Stumps planted up to a fortnight after the break of rains were better off than seedlings transplanted entire. Stumps with root lengths between 4" and 8" are all likely to give the best results.

A number of experimental plots were laid out in areas where *Bambusa polymorpha* had flowered in 1935-36 with the object of raising a reasonable crop of teak there both by stumps and direct sowing. Results so far indicate a failure in practically all cases of experiments with sowing, whereas stump planting has proved admittedly superior.

In the teak seed origin experiments in Myitkyina, attacks by *Hoplothammus* have been much more serious on the crops from Indian seed origin than that from Burma origin.

Extensive work has been in progress with working plans. Interim measurements in the matchwood sample plots indicate that in a closed forest, growth of matchwood species, viz., *Streulia*, *Bombax* and *Anthocephalus* is not very fast, as is often thought.

*Central Provinces.*—The natural regeneration of teak in North Chanda and the better class of forest following clear felling is generally unsatisfactory owing to the heavy undergrowth of bamboos. Methods are being worked out for felling the bamboos in a manner to foster natural regeneration. Moderate grazing and light shade seem to be factors favourable to teak regeneration in this province. Interesting experiments in the natural regeneration of *semal* (*Bombax malabaricum*) are in progress. The thinning of young teak is a major problem in this province.

*Coorg.*—A considerable amount of work has been done on the propagation and after tending of sandal. It appears that sandal is best grown as a road side tree or in lines widely spaced, that it should be given plenty of growing space and free circulation of air and never allowed to become parasitic on its neighbouring sandal. Sufficient good host plants such as *Cassia sinuata* must be provided. It has been decided to plant a line of sandal along the outside of all teak plantations. The natural regeneration of the evergreen forests particularly of *Vateria indica* is becoming standardised.

*Madras.*—The importance of the *rab* method of regenerating dry fuel forests is shown by the fact that under ordinary coppice working 7 per cent. of the stools die at each coppice rotation. The gradual degradation of thorn and scrub forest worked under coppice is unfortunately a well known feature of Indian forestry and the *rab* system affords a method of rejuvenating coppice coupes by artificial regeneration. Further work has also been done on the

pre-monsoon planting of teak stumps and the correct size of stumps to use. Experiments continue to show that for teak, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia crenulata* and *Artocarpus hirsuta* stumps are preferable to any other method. Research has shown that the replacement of casualties in the second year of a teak plantation is of very doubtful value. Scraping as opposed to forking as a method of weeding young teak plantations is hardly inferior in results and gives an immediate saving of Rs. 3 to Rs. 5 per acre each time this operation is done. Experiments continue in the regeneration of evergreens and on the spike disease of sandal. The eradication of lantana by spraying with a sodium chlorate spray show that the method is the most successful and least expensive of any so far tried.

*North-West Frontier Province.*—The main silvicultural problem continues to be the natural regeneration of blue pine (*Pinus excelsa*). The young regeneration suffering very heavy mortality in times of drought. The tube planting of *Pinus longifolia* has been used with success under very difficult site conditions at Cherat.

*Orissa.*—The natural regeneration of sal in Puri where evergreen conditions have become established is the chief problem of the new province. The thinning of teak plantations is also urgent.

*Punjab.*—The natural regeneration of deodar and the two pines *P. excelsa* and *longifolia* presents no difficulty. The regeneration of the firs has been a silvicultural problem for a long time and experiments confirm the opinion that excessive humus inhibits reproduction. 1½ million seedlings of *Morus alba* and *Melia azedarach* were handled in planting operations in the irrigated plantations. A useful record on mulberry by Mr. I. D. Mahendru was published. Considerable work has been done on exotics both in the plains and the hills. In the hills *Thuja plicata* has done very well and is much the most promising species tried. Counter erosion work continues to receive much attention throughout the province.

*United Provinces.*—The problem of first importance is the natural regeneration of sal *de novo* under the uniform system. Progress has been made and the position upto date is adequately summarised in Mr. Smythies article of April 1936 and Mr. Mobbs of August 1936 in the *Indian Forester*. Artificial regeneration on a large scale has now become a routine measure in many divisions both with and without *taungya*. Considerable attention is being paid to resin tapping investigations. Both here and in the Punjab treating blazes with a solution of Hydrochloric acid has not given an increased yield. The fourth edition of Mr. Howard's valuable Forest Pocket Book was published during the year.

### *Botany.*

On the whole Divisional Forest Officers find little leisure for botanical work. Dr. Bor in Assam has been able to add a good deal to the knowledge of the grasses of Assam and several plants new to the Assam flora have been collected by Mr. Purkayastha. Generally the identification of tropical evergreens is the most important botanical investigation required and this work is being continued.

The progress of Forest Botany in Burma was continued by good work done in the Maymyo herbarium which was maintained in the usual good condition and to which additions of herbarium specimens were made from collections made by local Forest Officers and from a donation made by the Dehra Dun herbarium. An interesting collection from the Wa States on the Sino-Burma boundary was obtained by a collector who accompanied the Boundary Commission. The Maymyo Botanical garden continued to make good progress; additions in planting and to the orchid house and rose garden were made as well as improvements in the upkeep of the roads and lawns. The public continues to appreciate these gardens which stimulate and help gardening in Upper Burma in general and in Maymyo in particular where, it is pleasing to note, the Annual Flower Show has been revived after being in abeyance for six years.

### *Entomology.*

The only possible way of dealing with epidemics of defoliators appears to be by methods of biological control and so far as teak in Nilambur and mulberry in the Punjab plantations are concerned this matter is being taken up in earnest. The Burma report contains some interesting particulars regarding the bee hole borer of teak which fortunately is absent from India.

### *Utilisation.*

In several provinces the appointment of Utilisation Officers has increased interest in the most profitable exploitation of our forest resources. The utilisation of new species of timber, bamboos and grasses and the attempts to start new local industries making use of such products has made some progress but vested interests and conservative habits frequently stand in the way. It must be realised that it is useless attempting to develop a trade in any product which is not available in commercial quantities. Too often when uses have been found for a timber it is discovered that supplies are not available. In some provinces many sorts of timber can be

grown in plantations and it has not yet been decided what trees should be grown from the point of view of utilisation as opposed to silviculture. The grading of timber also demands attention, the grading rules for Burma teak are now published and are being examined in practice. Grading rules for other timbers produced departmentally in large quantities demand consideration. Revised specifications for sal sleepers were under investigation during the year and it is hoped that a specification having a nearer relation to reality than the present one will result. Box woods are in increasing demand and will have to be provided by plantations, the present scattered nature of these trees renders an annual supply at economic rates quite impossible. Burma as usual has been very active in all branches of timber utilisation and is fully equipped in this respect.

An interesting forest exhibit was staged by the United Provinces and the Forest Research Institute at the Lucknow Exhibition which attracted a good deal of public attention.

A Utilisation Conference was held in Dehra Dun in March at which many problems of current interest were discussed and some important resolutions passed.

## CHAPTER II.

## SILVICULTURE AND WORKING PLANS.

## ASSAM.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

*Staff.*—The post of the Silviculturist continued to remain vacant throughout the year. Mr. C. Purkayastha, Deputy Conservator of Forests, was in charge of the work in addition to his duties of Botanical Officer up to the 1st November 1936 when he was relieved by Dr. N. L. Bor, D.Sc., I.F.S.

It has not yet been possible to sanction even the minimum staff recommended by the third Silvicultural Conference in 1929.

A full programme of work was carried out in addition to the inspection of Divisional plantations.

There were 16 experimental plots (including the two experimental gardens) at the beginning of the year of which two were made over to the Division. Two more experimental plots were newly laid out while an old experiment of Sibsagar was reconstituted during the year.

(ii) *Natural Regeneration.*

## A.—Evergreen Climax Forests.

The investigations of the past few years have proved what has been known in Assam for a considerable time and has been prescribed in the working plans for Lakhimpur and Sibsagar, that the correct method of regenerating our *Dipterocarpus*—*Mesua* climax forest is to open the canopy, reserve a portion of the smaller trees and to tend the young growth. Experience has shown that after the forest has been exploited, advance growth of valuable species appears in quantity and will persist for many years even if it is not tended. Tending alone will ensure a considerable advance in the rapidity of growth, but cutting a number of the smaller trees in addition results in even better growth.

During the past year about 90 acres of an area in the Jeypore reserve, Lakhimpur division, which was exploited in 1927-28 and



tended subsequently for a number of years, was opened up by the Divisional Forest Officer by cutting a number of the smaller trees, bamboos and undergrowth. This operation revealed that the area was fully stocked with *Mesua* and *Dipterocarpus* and with a fair number of other valuable species such as *Magnolia*, *Manglietia*, *Amoora*, *Michelia*, etc. Many of these had already become established. Experimental plots were laid out in three areas in order to determine the comparative value of tending every year, every second year and every third year. Tending, by which is meant, the keeping down of creepers and cutting out of undergrowth interfering with valuable species, costs money, a factor which will continue to loom very largely in our treatment of these forests.

If the *Dipterocarpus*—*Mesua hylium* is a climax, that is, an organic entity produced and controlled by a given set of climatic factors, and there is no doubt that it is, it would be expected that it could regenerate itself without outside interference. It can and does reproduce itself, albeit very slowly, but since man takes a hand in the exploitation of the forest thereby upsetting the very delicate balance of biotic factors, he must also take a hand in controlling the luxuriant growth of weeds and climbers which are the result of this exploitation, if the replacement of exploited trees is the object in view. The greater the opening the more insistent will be the need for tending.

In the experimental plot No. 8 opened near Digboi, which had for its purpose the determination of the progress of regeneration under different degrees of canopy density, it was found that seedlings of valuable species up to 4' in height occurred all over the area. Since the canopy was opened the progress of recruitment has been little short of amazing. In one square 6' x 6' no less than 23 seedlings of *Artocarpus chaplasha* were found. The same result has been achieved over the whole plot where the terrain is not too steep.

*Darrang type evergreen*.—Experimental cleaning of undergrowth under mother trees of various species has shown that profuse natural regeneration can be obtained by this means; 3,300 seedlings were counted under one *bonsum* (*Phacbe goalparensis*) tree. *Bola* (*Morus laurigata*) regenerates itself with ease by this method but the foci prove very attractive to deer and the areas are not now cleared. The indications are that the undergrowth protects the young plants from deer and that they are able to make their way through it.

## B.—Sal forests.

(i) *Kamrup*.—All P. B. I. areas continued to improve on the progress made in the last 2 or 3 years. The luxuriant weed growth that characteristically invaded the groups when initially opened out has been brought well under control by selective rains tending. *Eupatorium*, it has been noticed, does not prove detrimental to the existence of sal seedlings though it certainly arrests their growth. On uprooting the weed, dense patches of healthy seedlings have been revealed in many places. This practice is now steadily followed and forms an important part of rains tending activities.

The methods now adopted for regeneration may be summarised as follows:—

(a) In unopened areas.—(1) A preparatory felling involving an almost uniform removal over the area of the lower story of sal (consisting of suppressed and crooked stems and stems that would come out in a normal thinning) and of trees of miscellaneous species—except where their removal would result in a large gap in the canopy, (2) tending during the rains, involving cutting off of coppice shoots and shrubs, and the pulling out of weeds that become worse with cutting such as *Eupatorium*; (3) a carefully planned programme of forced burning all through the cold weather and (4) formation of groups by selective removal of trees in the canopy over promising patches of regeneration, to be gradually enlarged as regeneration progresses.

(b) In the groups previously formed, regeneration work has mainly consisted of (1) selective rains tending and (2) careful practice of burning technique, followed by (3) extension by removal of trees on the edges of the groups as regeneration progresses.

(ii) *Kachugaon*.—There was a certain amount of seeding of sal trees in P. B. I. in Bamba block. According to Inspector General of Forests' recommendations, compartment 3 was selected for wholesale weeding of sal recruitment at the end of the year. In half of the area, weeding was done in lines 3' wide 6' apart, and in the other half all weeds were removed. It was found that the recruitment was not so good, specially in the area where only line weeding was done. These lines have been sown broadcast with sal seeds at the end of the year to supplement the recruitment. The whole of the area was fire-protected.

No thatch has made its appearance yet in the *sau* observation plot in the Bamba block. It will not be wrong to conclude now, after 5 years of experiment, that thatch will spread once it has come whether the area is burnt or not, but it takes long to make its appearance in any locality where it does not already exist.

(iii) *Darrang*.—Very considerable success has been attained by opening the canopy and tending sal recruitment.

### (iii) *Investigation of seeds.*

The most important problem to be solved is the germination of the valuable *Magnoliaceous* species found in Upper Assam that has just been taken up. These species, which possess seeds enveloped in a crustaceous testa, either show very poor power of germination or else remain dormant in the soil for considerable periods.

Germination tests were carried out on many species in the experimental gardens. Seeds of *Sagerea* sp., obtained from the Silviculturist, Dehra Dun, failed to germinate in every case although they were distributed all over the province and sown in a variety of soils.

The following bamboos flowered during this year:—

*Cephalostachyum pergracile*, Lakhimpur.

*C. capitatum*, Khasi and Jaintia Hills.

*Dendrocalamus hamiltonii*, Sibsagar.

*Bambusa pallida*, Sibsagar.

*B. tulda*, Sibsagar.

*Dendrocalamus hookeri*, Khasi and Jaintia Hills.

*Arundinaria* sp., Khasi and Jaintia Hills.

### (iv) *Investigations on Trees and Crops.*

As in last year's report.

### (v) *Nursery Work.*

Nurseries are being opened at each plantation centre in ever-green divisions in order to raise valuable evergreens for transplanting.

### (vi) *Artificial Regeneration.*

(a) *Dipterocarpus macrocarpus*.—The reported low germination of this species is incorrect, for with correct selection of fruits as much as 70 per cent. germination can be achieved.

(b) *Lagerstræmia flos-reginæ*.—Results so far obtained from the stump planting experiment indicate that the early planting is far more preferable to the later.

(c) *Artocarpus chaplasha*.—The stump planting experiment of last year's report was repeated. A borer destroyed the leading shoot of nearly all the plants.

#### (vii) *Tending.*

Experiments have been laid out in *hollock* plantations in Lakhimpur to find out whether there is any advantage in spacing out the stems in 1 year old and 2 year old plantations.

#### (viii) *Mixtures.*

Experience has shown that mixtures of (1) *Amoora* and *Phæbe* and (2) *Altingia*, *Manglietia* and *Cinnamomum* grow very well together. Experimental plantations of various evergreen species are being started.

#### (ix) *Underplanting.*

Experimental plantations of *Mesua ferrea* and *Amoora* under *Terminalia myriocarpa* have been started.

#### (x) *Silvicultural Systems.*

Nil.

#### (xi) *Miscellaneous.*

A start has been made in systematising the record of preservation plots.

In all divisions a 10-year planting scheme is being drawn up and forms for standardising records are being issued.

### BENGAL.

#### I.—EXPERIMENTAL SILVICULTURE.

##### (i) *General.*

Mr. R. I. Macalpine, I.F.S., was in charge of the Silvicultural division upto the end of October 1936 and Mr. C. K. Homfray, I.F.S., from the 1st November 1936 till the 18th February 1937, thereafter Mr. S. J. Curtis, I.F.S., for a short term only till

Mr. J. C. Nath, I.F.S., took over from him on the 18th March 1937 and continued for the rest of the year. The Central Silviculturist and Silviculturist, Madras, toured in South Bengal with the Silviculturist, and visited most of the silvicultural plots in Chittagong, Chittagong Hill Tracts and Sunderbans divisions.

(ii) *Natural Regeneration.*

(i) *Sal*.—In Buxa division attempts to naturally regenerate areas in the Bhabar tract have not yet met with very great success. As a result of the survey of the position made at the close of last year, the evergreen shrubs and coppice in the undergrowth were cut back and burnt, and the area (Santrabari plot) was weeded once in the rains, with the result that luxuriance of the undergrowth has been considerably reduced and there has been an appreciable increase of sal seedlings.

In the Raimatang Bhabar, though the replacement of *Pollinia ciliata* by *Imperata arundinacea* is slow, there has been an increase of sal seedlings, particularly where the canopy is more open and the undergrowth light. The conditions have not yet sufficiently changed to justify regeneration fellings and rains weeding.

In Darjeeling division, the experiments undertaken by the territorial staff have not yet yielded very hopeful results, though a certain amount of recruitment has been obtained where the canopy is open.

The Conservator of Forests and the Silviculturist visited Kamrup (Assam) in April and September 1936 to compare the Kamrup method and technique with those adopted in Bengal with a view to formulate a definite scheme for natural regeneration of sal in Bengal. A series of 12 experimental plots was accordingly laid out in different sal divisions for studying the applicability of the Kamrup method. The Divisional Forest Officers of Buxa and Kurseong also laid out similar plots. Besides, extensive areas in Buxa, Jalpaiguri and Kurseong were taken up, which were burnt with moderate intensity as far as possible. It is intended that by continued repetition of this process the present evergreen conditions of undergrowth (resulting from a prolonged fire protection) which have proved inimical to sal regeneration will be reversed. In many places, where conditions were too wet and undergrowth too evergreen to burn, focal points were started, where the undergrowth was cut and fired when dry. It is hoped that repeated burning from these focal points will result in ever widening areas of drier conditions favourable to sal regeneration.

In Dacca-Mymensing division, natural regeneration is of secondary importance, as coppice regeneration is quite satisfactory in the greater portion of the area. A careful study of the progressive growth of natural seedlings which are plentiful, was however, continued with the object of possibly replacing casualties in coppice stools or filling up blanks.

(ii) *Other species*.—(a) A series of plots have been laid out in Jalpaiguri division to study the effect of a burn of moderate intensity on the existing reproduction of *khair* and *sissoo* in the savanna areas in river forests and to see if this treatment would induce further recruitment of natural regeneration.

Experiments have also been started to regenerate natural grassy blanks in high forest in Buxa division by burning and controlled grazing, supplemented by rains broadcasting of seeds of miscellaneous species.

(b) *Evergreen forests of Kassalong, Chittagong Hill Tracts*.—The results of last seven years' work on these experiments, to determine a method of removing the existing overwood which would ensure an establishment of advance growth of valuable species already on the ground, are very encouraging. A large scale Divisional experiment has therefore been started to find out whether, and at what stage, it will be possible to carry out intensive fellings in such areas, as the success of departmental extraction largely depends on them.

(c) *Dipterocarpus* spp.—“Notching” of *Dipterocarpus turbinatus* under high shade on a Divisional scale has proved very successful at a low cost. But there has been very little success with *Dipterocarpus costatus* and *Dipterocarpus pilosus* and experiments with these latter species were continued.

An experiment to introduce *Eugenia grandis* by “notching” has also proved successful at a low cost.

Experiments on tending the patches of pole crops of *garjan* which occur throughout the Chittagong division were continued. The effects of cutting back the miscellaneous species and that of fire in reducing the undergrowth are being watched.

An experiment to test the suitability of the Kamrup method of natural regeneration of sal to *garjan* in Cox's Bazar has been started in a *Dipterocarpus costatus* area.

### (iii) *Nursery and Plantation Work.*

Nurseries were maintained at Takdah, Sukna and Hazarikhil.

*Takdah (Darjeeling).*—17 species of seed were sown during the year. Seedlings of these, mostly exotics, are planted out in the Darjeeling divisional plantations by the territorial staff. *Cupressus torulosa*, *Cupressus cashmeriana* and *Juniperus virginiana* are showing the greatest promise.

*Sukna (Kurseong).*—Routine experiments were made of various indigenous and exotic species. Those of interest are *Cassia siamea*, *Aleurites fordii*, *Pterocarpus marsupium* and *Eucalyptus citriodora*. *Acacia lenticularis* has done extremely well and shows promise of rapid growth.

*Hazarikhil (Chittagong).*—Routine tests were carried out for numerous species. Among the exotics *Xylia dolabriformis*, *Pterocarpus dalbergioides* and *Eucalyptus citriodora* show promise.

*Stump planting.*—Experiments on stump planting of various species were continued in many divisions. In Darjeeling, field nurseries of *buk* (*Quercus lamellosa*) and *phalant* (*Quercus lineata*) were started in all new plantation areas with the object of raising seedlings for stump planting in the future. In Kurseong, experiments with *buk*, *phalant* and *maya* (*Eriobotrya petiolata*) gave very good results. These experiments are of particular interest for hill plantations, where normally species raised from seed or transplants exhibit very slow growth and costs of tending are heavy.

*Fuel taungyas.*—These were continued in Kalimpong division with encouraging results. *Mandane* (*Arocarpus fraxinifolius*), *lampati* (*Duabanga sonneratioides*) and *Albizia* spp. seem to be the most promising for a 12-16 year rotation.

“*Kharkhani*” areas.—Experimental sowings of sal on bumps in a low-lying area (*Kharkhani*) in Buxa division are progressing well so far.

*Bamboos.*—The experiments at Baraiyadhala (Chittagong) on the introduction of the bamboos (*Melocanna bambusoides* and *Bambusa tulda*), in the poor, dry, deciduous forests were closed at the end of the year as they have fulfilled their object. One year old rhizomes are the best for the purpose and it is a practical and profitable proposition to plant rhizomes of *Melocanna bambusoides*, which has a greater local demand than *Bambusa tulda* in this type of forest.

An experiment to examine the possibility of introducing the exotic *Bambusa polymorpha* from Burma in the same type of forest has been started this year.

*Cover crops.*—Experiments on cover crops were continued. *Leucæna glauca*, *Tephrosia purpurea*, and *Lea crispa* are not considered as suitable as *Tephrosia candida*.

*Plantations of exotics in the Darjeeling Hills.*—Planting of exotics and other experiments were continued. *Alnus incana*, *Cupressus torulosa*, *Cupressus cashmeriana*, *Juniperus virginiana* shew promise of rapid growth.

Experiments to reduce the rate of growth of *Cryptomeria* by closer planting were continued.

*Mixtures in plantations.*—There is little to add to previous years' reports as it will take time to obtain conclusive results.

*Underplanting.*—Experiments with *Dipterocarpus turbinatus*, *Dipterocarpus pilosus*, *Dichopsis polyantha*, *Artocarpus chaplasha*, *Hopca odorata*, *Swietenia macrophylla* were continued with success.

*Thinnings.*—The thinning note (by Mr. C. K. Homfray) mentioned in last year's report was published during the year, and its principles were generally followed in silvicultural sample plots and divisional thinnings.

Experiments in earlier thinning of sal, viz., in 3 to 4 year old instead of in 6 year old plantations, with a view to reduce the tendency to form epicormics, were undertaken during the year; it is too early yet to form any opinion on the success of the experiment.

All other experimental thinning plots were maintained and remeasured as due.

*Eradication of climbers.*—As stated in last year's report, hoeing up of roots is the best method in young plantations. Coppicing of climber-damaged (due to *Tinospora cordifolia* and *Mucuna pruriens*) 5-10 year old sal, followed by a hot burn, cleaning and hoeing up of the climber roots, has proved very successful. In 2 years, the sal coppice attains a height of 8'-15'. In Jalpaiguri division 183 acres of sal plantation were thus treated with the result that they are now far cleaner, healthier and more vigorous than the original crop.

Experiments to study the effect of a burn of moderate intensity on the incidence of creepers, were undertaken in Dacca-Mymensingh division, but it is too early to form definite conclusions.

*Controlled burning in sal plantations.*—Controlled burning in sal plantations, of over 8 years old, was carried out in Kurseong,



Buxa, and Jalpaiguri divisions for the eighth year in succession. This has resulted in reducing the evergreen undergrowth associates which are changing to a drier type and the general appearance of sal is more healthy than unburnt plantations. An annual burning of a moderate intensity is carried out in the cold weather.

All experimental plots to study the effect of controlled burning on the undergrowth, crop, soil conditions and cost of climber cutting were maintained. The results indicate that the operation is certainly beneficial.

Experimental plots were laid out in Dacca-Mymensingh to study the effect of annual burning of a moderate intensity on the incidence of a defoliator in sal.

#### (iv) *Preservation of Natural Flora.*

Twenty-seven plots were maintained and more plots will be laid out in due course.

#### (v) *Soil samples.*

Mention was made last year of a report from Dr. J. C. Ghosh, D.Sc., on the soil samples from sal forests. A further study of the corresponding soil profiles to draw final conclusions on the effects of burning in sal plantations will be taken up next cold weather.

#### (vi) *Special investigations.*

(i) *Pruning.*—Results of last year's experiments on sal in Buxa division indicate that pruning, either flush to the bark or down to the cambium layer, does not reduce the original number, vigour and growth of the epicormics, and that the pruning down to cambium is definitely harmful.

(ii) *Limitation of species.*—This is still under discussion and will, it is hoped, be completed at the next Divisional Forest Officers' Conference.

(iii) *Cryptomeria japonica.*—The closer planting experiments (by varying planting distances) to improve the quality of this timber by reducing the rate of growth were continued.

### II.—WORKING PLANS AND STATISTICS.

(i) *Working plans.*—The revised working plan for the Kalimpong division was published during the year.

The revised working plans for Chittagong and Cox's Bazar were still under compilation.

(ii) *Linear sample plots*.—Routine remeasurements were done to the old plots. A new plot was laid out in the Upper Hills of Kurseong covering species occurring between the elevation of 6,000 and 7,000 feet.

(iii) *Ring-counting and stem analyses*.—A bulletin containing up to date results for the more important species of the hills and the plains was prepared and sent to the Press during the year.

## BIHAR.

### 1.—EXPERIMENTAL SILVICULTURE.

#### (i) *General*.

Mr. W. D. M. Warren, I.F.S., was in charge of the division throughout the year, besides the charge of Working Plans and Utilisation.

#### (ii) *Natural Regeneration*.

*Contour trenching experiment in Palamau*.—Experimental plots were laid out to ascertain whether contour channel irrigation, by arresting the run off of hill side water, hastens the infilling of blanks with regeneration in dry sal areas. Only six sal trees of 6" - 8" diameter surround the area, and at present none of these have specially good crowns, nor any regeneration present.

*Sal seeding, Palamau division*.—Two more experimental plots were laid out, to ascertain at what age sal coppice shoots give fertile seeds. Results from the existing plots shewed that seeds from 6 year old shoots gave no germination, from 7 to 11 year old shoots only 1 to 3 per cent. germination and from 13 to 14 year old shoots 10 per cent. germination, all in nursery beds.

*Burning, Saranda Experimental Plots*.—The fire protected plot shows fully stocked forest with ample regeneration. The middle-aged top canopy is sufficiently complete to prevent the underwood from developing rapidly. The underwood is thick and consists of sal regeneration, creepers such as *Millètia*, *Bauhinia*, and *Smilar* and regeneration of miscellaneous trees. Thinning in the overwood and cutting back miscellaneous trees and creepers, until the sal underwood is established, are considered necessary. The plot shows the usual healthy appearance of moist peninsular type sal forest.

The appearance of the experimental plot, annually burned for the last 12 years, is very different. There is no underwood of more than 2' in height, several of the sal poles are top dry and have produced epicormic branches and the few burnt-back seedling regeneration produce 2-3 unpromising shoots per stool, averaging only 2' in height with little fresh recruitment. There is a characteristic barrenness of soil with an absence of grass and vegetative cover and consequent surface erosion. Enumeration figures show that only 4 saplings have progressed to the tree stage since 1925, and that there are now no saplings and only 78 established regeneration as against 46 and 247 respectively in 1925. The appearance of the whole plot is that of an isolated dry area in the midst of healthy vigorous growing forest exhibiting the evil effects of annual burning for a number of years.

*Saranda Experimental Plots 3 and 15* were laid out in 1923-25 to ascertain how long it takes for sal regeneration to establish itself in middle aged, moist peninsular good quality sal forest with fire protection as against annual burning.

*Saranda Experimental Plots 5, 6 and 7.*—The object was to ascertain in these damp types of sal forest which of the three methods, *viz.*, (i) burning once after clear felling, (ii) control, without burning after clear felling, and (iii) burning for five years before clear felling, will help sal regeneration to successfully compete with other mixed species. Results seem to suggest that burning after clear felling is not necessary to enable sal regeneration to compete with other species, but that a cleaning at some later stage is essential in order to free the regeneration from competition, and that continued burning before clear felling hinders definitely, rather than helps, the establishment of sal though it also hinders the evergreen species in competition with it.

(iii) *Seeds (collection, weight, germination per cent., etc.)*

A number of species were tried under germination test in nursery beds as well as under field conditions in the experimental garden at Hino.

*Teak.*—The simplest method of seed treatment giving good average results, is alternately to soak and dry the seeds on a cement floor until germination commences and then to sow the germinating seeds in beds at the correct-distance (say 9" x 9") for future development. Seeds that do not germinate even after soaking and drying for about one month should better be put out straight into beds, much closer than the pre-germinated seeds (say at 3" x 3" or 3" x 6" apart). Experience suggests that seeds should be sown early

in May so that they may be germinating with the first showers of monsoon. Seedlings that had been crowded in germinating beds while planted out, showed much poorer growth than those left behind undisturbed. This, in fact, goes against too close a sowing in the germinating beds where seeds must be well spaced out with a view to the required number of future transplants. Experience has also shown here that one year old teak stumps can be stored, without damage, for at least 14 days before planting out, and can, therefore, be sent long distances.

#### *Other experiments.*

*Cold weather stump planting.*—Out of six different species, put out in pits 1' deep and 6" squares in December 1935, *Bombax malabaricum* was the only species that came out successfully with a survival percentage of 96 and the average height of 10" on the 1st June 1936 and 76 and 13" respectively on the 1st June 1937. This height growth is definitely better than that of rains and hot weather stump plantings, which, however, gave better percentages of survival.

*Rains stump planting.*—25 stumps, with 9" root and 1" shoot, of each of the following species were put down in pits 1' deep and 6" squares on the 30th June, 1936. The percentages of success obtained and heights recorded on 1st June 1937 are stated below:—

*Tectona grandis* 84 per cent., 4"; *Bombax malabaricum* 84 per cent., 4"; *Acacia churra* 44 per cent., 16"; *Hymenodictyon excelsum* 97 per cent., 5"; *Pterocarpus marsupium* 80 per cent., 8"; *Albizia lebbek* 92 per cent., 7"; *Albizia procera* 92 per cent., 7"; *Acacia catechu* 80 per cent., 4"; and *Terminalia tomentosa* 48 per cent., 12". The last two species were stumps of two season old plants, the rest of one season old.

*Amoora wallichii.*—300 seeds were sown in nursery beds and in lines in field conditions in July 1936. In the following December the plant per cent. in the former was 85 with an average height of 6", while the latter had 70 per cent. with an average height of 5½".

100 entire plants, 3 months old, were transplanted in December 1936, out of which only 64 survived with an average height of 6" on 1st June 1937.

*Eucalyptus species.*—Australian seeds of *E. rostrata*, *E. macrocarpa*, *E. citriodora* (also from Forest Research Institute), *E. siderophloia*, *E. riminalis* and *E. tereticornis* were tested for germination and in the field with disappointing results. None can be recommended for general field conditions where attacks from

white ant are to be feared. Where conditions are favourable *E. citriodora* and *E. rostrata* may be tried, and entire transplanting from boxes and from manured beds gave quicker growth than from pot tiles.

*Michelia champaca*.—Equal numbers of seeds which sank and floated were tested in the nursery bed and the germination per cent. was 46 against 57 obtained with good seeds only, yet in another test the floating seeds did not germinate at all. In either case heights in one season were 30", 20" and 10" for the highest, average and smallest plants respectively. The beds were shaded by bamboo *chicks*. Germination was also tested in beds without shade. Good seeds, which had survived the water test, gave 27 per cent. germination against 22 per cent. given by the equal mixture of good and bad seed. The heights of one season old plants were 30", 20" and 10" for the highest, average and smallest plants respectively.

Seeds sown in boxes without shade gave only 32 per cent. germination with average heights of  $3\frac{3}{4}$ ",  $2\frac{1}{4}$ " and  $1\frac{3}{4}$ " for the highest, average and smallest plants respectively in 3 months.

168 plants  $1\frac{1}{2}$  months old were transplanted in manured beds (6 kerosene tins of farmyard manure per bed of 80 square feet) 2" apart in lines 8" apart. The survival percentage is 89 and the average height recorded in June 1937 is 9". All the plants are growing very healthily.

*Robinia pseudoacacia* (Black Locust).—A water test was made with the seeds and those which sank gave 70 plant per cent. against 60 per cent. given by the unselected seeds. Germination took place within five days and the seedlings are very quick growing, the average height being 20" in one season. This species is reported from America to have a good spreading root system and well suited for fixing soil on unstable eroded lands and to survive under xerophytic conditions.

*Host plant of sandal wood experiment*.—Three months old entire transplants of *Santalum album* were put out in pits 1' deep and 6" squares in July 1936 under various host plants to determine which is the best host. Results so far indicate that *Shorea robusta* appears to be the best host plant, though plants under *Cassia siamea*, *Pterocarpus marsupium* and *Melia azedarach* are also promising. Survival and growth are discouraging under other host plants, viz., *Acacia macroflora*, *Albizia procera* and bamboos.

*Bamboo planting in Palamau*.—14 seers of Angul *Dendrocalamus strictus* seed sown broadcast germinated well, but later

70 per cent. of the plants died. 16 pieces of mature bamboos about 4 feet in length were buried inside the ground. Before burying water was filled in the hollow portion by making holes in the internodes, the holes being kept up to prevent water from leaking. New shoots came out on 3rd August 1936 and looked very healthy but they are now all dead. On digging up a few pieces it was found that while shoots were thrown up from the nodes, no roots were sent into the ground.

*Alcurites fordii* (tung oil) in Palamau.—All healthy looking plants were planted out in July 1936 which were living up to November 1936 after which rats began to attack them and out of 54 only 18 are now surviving.

#### (iv) Nursery work.

Nil.

#### (v) Artificial regeneration, including taungya.

Palamau.—Experiments are continuing with the planting of Indian and exotic species for beautifying the plateau. Water-logging and white ant damage are the two main problems to be tackled in the nursery. Coniferous plants show a tendency to damp off and draining has proved beneficial.

Of the species tried so far *Eucalyptus citriodora*, Cypressess and *Thuja orientalis* appear to do well though the first two are susceptible to attack by white ants.

Of the three species tried in the swamp plantation at Rud, viz., *Albizia procera*, sissoo and *khair*, *Albizia procera* (sirís) did best and *khair* the worst.

#### (vi) Reclamation and afforestation.

Chaibassa.—Broadcast sowing in a protected forest block of *Zizyphus*, *Gmelina*, *Terminalias*, etc., and sal failed; even root and shoot cuttings of teak died.

#### (vii) Tending.

Thinning Research.—Two sets of research thinning sample plots were laid out in Saranda and Kolhan divisions, with a view to determining the age and intensity of first thinnings in young sal pole crops. Taking 7' average spacing as standard "C" grade thinning, "D" grade, 75 per cent. of "C", gave 8' - 1" spacing and "E" grade, 50 per cent. of "C", gave 10' average spacing.

with enumeration figures of 1026, 769 and 512 respectively per plot. Subsequent inspection seemed to show that the "E" grade thinning is too severe.

(viii) *Mixtures.*

Nil.

(ix) *Under-planting.*

Nil.

(x) *Silvicultural systems.*

Nil.

(xi) *Miscellaneous.*

*Irrigation of dry hill sal areas, Kolhan.*—The contour trenching experiment at Bamiaburu continues to be a source of interest even outside the province.

The area was visited by the Inspector General of Forests in February 1937, who observed that all attempts to conserve moisture and prevent run off must be beneficial in areas of poor growth, and provided the work could be done at a reasonable cost were to be commended. Adoption of contour trenching would, it is hoped, increase considerably the yield of fodder for cattle in upland areas which cannot be brought under systematic cultivation.

His Excellency the Governor of Bihar also visited this area in June 1937, which has given the experiment great publicity in the press, and we may hope to find the principle more widely practised in the near future.

The Bamiaburu experiment now extends to 25 miles of trenches, about  $21\frac{1}{2}$  miles of which were added during the year, at a cost of Rs. 1,124, with Rs. 343-1-9 for meteorological instrument and chart papers. Another experiment was started at Roro, some ten miles away, where the first ten miles of trenches were dug this year.

*Contour irrigation, (i) Palamau.*—New perennial pools of water were observed to form in the *nala* at Mako. At Kundri the *palas* (*Butea frondosa*) trees along the trench seemed generally to produce bigger and much darker green leaves than those away from it. At Saidope, difficulty was experienced in keeping the trenches level. The Lat erosion experiment (not definitely contoured), started in 1934, gives one the impression that the influx of sal

regeneration will be slower here than at Bamiaburu with, however, a tendency for more to come in under the shade of mother trees.

(ii) *Chaibassa*.—Broadcast sowings of *Terminalias*, *Butea frondosa*, *khair*, etc., along with *Tephrosia* on the contour trenched area did very well, and thatch grass showed accelerated growth.

(iii) *Santal Parganas*.—Success also attended afforestation efforts in Dhamaniapahar where contour trenching aided the establishment of the species. Stumps of teak and sissoo and broadcast sowing of various tree species were used.

## II. WORKING PLANS AND STATISTICS.

### (i) *Working Plans*.

The Saranda and Kolhan plans were sent to the press. A miscellaneous working circle for systematic working based upon enumerations carried out in both divisions was added to each plan.

The revised plan for Chaibassa received the Conservator's final approval after the close of the year.

A preliminary report for the revision of the working plan for the Khurchntta reserved and protected forests was submitted.

With a view to meet the demands of the *Turis* (basket makers) of Porahat for green immature bamboos a scheme—called the Bamboo Basket Working Circle, has been drawn up for Porahat and inserted in the working plan as an appendix.

The thinning scheme which was prepared in 1935-36 was partly revised during the year.

A preliminary report for the revision of the working plan for the reserved and protected forests of Kodarma was submitted.

A working plan for the Khasmahal forests of Rohtas and Rehal was extensively revised and a 40-year coppice-with-standard rotation is being introduced on the lines of the Porahat scheme.

### (ii) *Yield, Volume, and Form Factors*.

Twenty sample plots were remeasured under full measurements of which one, of teak, was clear felled and the final yield recorded. Two single tree increment plots of *Adina cordifolia* and *Ougenia dalbergioides* were laid out in Saranda division.

The collection of volume and outturn statistics of sal for Conversion Working Circle and Hill Working Circle coupes of Kolhan division was completed in some coupes and the registers sent to the Forest Research Institute, Dehra Dun, for statistical analysis.



## III.—MISCELLANEOUS.

(i) *Photography.*

A number of new photographs (120) were taken during the year and 4 new slides were added to the research collection.

(ii) *Weeds.*

Nil.

## APPENDIX.

*Germination test in nursery beds.*

| Serial No. | Species.                       | Date of sowing.    | Period of initial germination — days. | Period of final germination — days. | Germination per cent. | Date of measurement. | HEIGHTS OF PLANTS. |          |           | REMARKS.                                     |
|------------|--------------------------------|--------------------|---------------------------------------|-------------------------------------|-----------------------|----------------------|--------------------|----------|-----------|--|
|            |                                |                    |                                       |                                     |                       |                      | Biggest.           | Average. | Smallest. |  |
| 1          | <i>Arundo donax</i>            | 6th July, 1936     | 12                                    | 63                                  | 85                    | December, 1936       | 9"                 | 0"       | 3"        |  |
| 2          | <i>Arundinaria blanda</i>      | ....               | ..                                    | Failed                              | ..                    | ....                 | ..                 | ..       | ..        |  |
| 3          | <i>Broussonetia papyrifera</i> | 16th August, 1936  | 12                                    | 64                                  | 18                    | December, 1936       | 3"                 | 2"       | 1"        | In box.                                      |
| 4          | <i>Beta oleracea</i>           | 22nd April, 1936   | 20                                    | 121                                 | 3                     | Ditto                | 7"                 | 4"       | 3"        |  |
| 5          | <i>Hamdusa arundinacea</i>     | ....               | ..                                    | Failed                              | ..                    | ....                 | ..                 | ..       | ..        |  |
| 6          | <i>Clavus pentaphylla</i>      | 11th July, 1936    | 21                                    | 40                                  | 1                     | September, 1936      | 2"                 | 1½"      | 1"        |  |
| 7          | <i>Callistemon citrinus</i>    | 22nd October, 1936 | 30                                    | 57                                  | 2                     | June, 1937           | 32"                | 18"      | 0"        | Moltened seeds gave 7 per cent. germination. |
| 8          | <i>Cyperus teretifolius</i>    | ....               | ..                                    | Failed                              | ..                    | ....                 | ..                 | ..       | ..        | Seeds untreated.                             |
| 9          | <i>Canarium euphyllum</i>      | 12th April, 1937   | 38                                    | 68                                  | 10                    | June, 1937           | 7"                 | 5"       | 2½"       | Seeds soaked in mustard cake solution.       |
|            | Ditto                          | Ditto              | 38                                    | 68                                  | 8                     | Ditto                | 6"                 | 5"       | 2½"       | Seeds soaked in water for 72 hours.          |
|            | Ditto                          | Ditto              | 36                                    | 68                                  | 10                    | Ditto                | 0"                 | 7"       | 2½"       | Seeds soaked in water for 24 hours.          |
|            | Ditto                          | Ditto              | 36                                    | 68                                  | 34                    | Ditto                | 8"                 | 6½"      | 2½"       |  |

## Germination test in nursery beds—contd.

| Serial No. | Species.                          | Date of sowing.     | Period of initial germination—days. | Period of final germination—days. | Germination per cent. | Date of measurement. | HEIGHTS OF PLANTS. |          |           | REMARKS.    |
|------------|-----------------------------------|---------------------|-------------------------------------|-----------------------------------|-----------------------|----------------------|--------------------|----------|-----------|-------------|
|            |                                   |                     |                                     |                                   |                       |                      | Blagost.           | Average. | Smallest. |             |
| 10         | <i>Dendrocalamus strictus</i> .   | ....                | 8                                   | 12                                | ..                    | ..                   | ..                 | ..       | ..        | All died.   |
| 11         | <i>Dalbergia sissoo</i> .         | 15th July, 1936     | 7                                   | 27                                | 37                    | October, 1936        | 14"                | 1"       | 3"        |             |
| 12         | <i>Euphorbia tirucalli</i> .      | ....                | ..                                  | Failed                            | ..                    | ....                 | ..                 | ..       | ..        |             |
| 13         | <i>Gynerium americanum</i> .      | ....                | ..                                  | Failed                            | ..                    | ....                 | ..                 | ..       | ..        |             |
| 14         | <i>Morus alba</i> .               | ....                | ..                                  | Failed                            | ..                    | ....                 | ..                 | ..       | ..        |             |
| 15         | <i>Melastoma composita</i> .      | ....                | ..                                  | Failed                            | ..                    | ....                 | ..                 | ..       | ..        |             |
| 16         | <i>Mitchella repens</i> .         | 7th October, 1936   | 24                                  | 71                                | 46                    | June, 1937           | 20"                | 20"      | 10"       |             |
| 17         | <i>Melastoma composita</i> .      | 4th August, 1936    | 29                                  | 82                                | 59                    | July                 | 12"                | 6"       | 3"        |             |
| 18         | <i>Ocotea latifolia</i> .         | 21st March, 1937    | 12                                  | 14                                | 1                     | July                 | 9"                 | ..       | ..        | In box.     |
| 19         | <i>Platanus macrocarpa</i> .      | 22nd April, 1936    | 26                                  | 101                               | 3                     | December, 1936       | 5"                 | 3"       | 1"        |             |
| 20         | <i>Pterocarpus dalbergoides</i> . | July                | 14                                  | 131                               | 7                     | July                 | 41"                | 3"       | 1"        |             |
| 21         | <i>Pinus caribaea</i> .           | 16th March, 1936    | 16                                  | 39                                | 2                     | July                 | 2"                 | 11"      | 3"        |             |
| 22         | <i>Robinia pseudacacia</i> .      | 15th November, 1936 | 5                                   | 63                                | 70                    | June, 1937           | 25"                | 20"      | 3"        |             |
| 23         | <i>Santalum album</i> .           | 22nd April, 1936    | 20                                  | 83                                | 5                     | December, 1936       | 51"                | 31"      | 2"        | More seeds. |

|    | Ditto                       | Ditto              | 32 | 95 | 1  | Ditto      | 53" | 3"  | 13" | Sambalpur seeds. |
|----|-----------------------------|--------------------|----|----|----|------------|-----|-----|-----|------------------|
| 24 | <i>Sapindia febrifuga</i>   | 10th July, 1936    | 6  | 27 | 12 | Ditto      | 2"  | 1"  | 1"  |                  |
| 25 | <i>Sopihara secundifera</i> | 10th October, 1936 | 17 | 86 | 15 | June, 1937 | 2"  | 13" | 1"  |                  |

*Germination test in field conditions.*

(Line sowings.)

|   |                                | 1st July, 1936  | 7  | 61     | 50 | October, 1936 | 2"  | 13" | 1"  |   |
|---|--------------------------------|-----------------|----|--------|----|---------------|-----|-----|-----|---|
| 1 | <i>Albizia odoratissima</i>    | 1st July, 1936  | 7  | 61     | 50 | October, 1936 | 2"  | 13" | 1"  | It is possible that damper forest conditions might produce bigger plants better able to withstand weed conditions. Ditto.   |
| 2 | <i>Albizia procera</i>         | Ditto           | 7  | 24     | 58 | Ditto         | 3"  | 9"  | 13" |   |
| 3 | <i>Acacia catechu</i>          | Ditto           | 6  | 36     | 60 | Ditto         | 43" | 23" | 13" |   |
| 4 | <i>Amora neriifolia</i>        | 6th July, 1936  | 25 | 64     | 70 | Ditto         | 8"  | 53" | 23" | Can be sown in field conditions. The sturdiness of the plants indicates that it might be able to withstand weed competition with the help of cleanings carried out. |
| 5 | <i>Acacia eburnea</i>          | 14th July, 1936 | 4  | 22     | 11 | Ditto         | 1"  | 1"  | 4"  |   |
| 6 | <i>Barbus arundinacea</i>      | ....            | .. | Failed | .. | ....          | ..  | ..  | ..  |   |
| 7 | <i>Casuarina equisetifolia</i> | 1st July, 1936  | 21 | 92     | 5  | October, 1936 | 23" | 13" | 4"  |   |
| 8 | <i>Dendrocalamus strictus</i>  | ....            | 20 | 21     | 2  | ....          | ..  | ..  | ..  | All died subsequently.  |
| 9 | <i>Dalbergia sissoo</i>        | 14th July, 1936 | 10 | 15     | 48 | October, 1936 | 13" | 1"  | 1"  |   |

## Germination test in field conditions—contd.

| Serial No. | Species.                           | Date of sowing. | Period of initial germination = days. | Period of final germination = days. | Germination per cent. | Date of measurement. | HEIGHTS OF PLANTS. |          |           | REMARKS.  |
|------------|------------------------------------|-----------------|---------------------------------------|-------------------------------------|-----------------------|----------------------|--------------------|----------|-----------|---|
|            |                                    |                 |                                       |                                     |                       |                      | Biggest.           | Average. | Smallest. |   |
| 10         | <i>Eucalyptus rostrata</i> .       | 2nd July, 1936  | 11                                    | 14                                  | 17                    | November, 1936       | 4½"                | 2½"      | 1"        | Australian seeds.                                       |
| 11         | <i>Hymenoclydon erectum</i> .      | 3rd July, 1936  | 12                                    | 20                                  | 10                    | October, 1936        | 1"                 | ½"       | ½"        |   |
| 12         | <i>Morus alba</i> .                | 2nd July, 1936  | 22                                    | 27                                  | 2                     | ....                 | ..                 | ..       | ..        | All died subsequently.                                  |
| 13         | <i>Melia composita</i> .           | ....            | 15                                    | 10                                  | 3                     | ....                 | ..                 | ..       | ..        | Ditto.  |
| 14         | <i>Pterocarpus macrocarpus</i> .   | 2nd July, 1936  | 75                                    | 83                                  | 1                     | October, 1936        | 1½"                | ..       | ..        |   |
| 15         | <i>Pterocarpus dalbergioides</i> . | Ditto           | 34                                    | 41                                  | 1                     | Ditto                | 1"                 | ..       | ..        |   |
| 16         | <i>Pterocarpus marsupium</i> .     | 3rd July, 1936  | 15                                    | 20                                  | 20                    | Ditto                | 3"                 | 2"       | 1"        |   |
| 17         | <i>Pinus longifolia</i> .          | 4th July, 1936  | 25                                    | 47                                  | 18                    | Ditto                | 2"                 | 1½"      | 1"        |   |
| 18         | <i>Schinus molle</i> .             | 1st July, 1936  | 10                                    | 43                                  | 12                    | Ditto                | 1½"                | 1½"      | 1"        |   |
| 19         | <i>Santalum album</i> .            | Ditto           | 50                                    | 71                                  | 7                     | Ditto                | 3"                 | 2"       | 1½"       | Mysore seeds.   |
| 20         | <i>Scaevola macrophylla</i> .      | Ditto           | 72                                    | 112                                 | 6                     | Ditto                | 2"                 | 1½"      | 1"        | Sambalpur seeds.  |
| 21         | <i>Soybean</i> .                   | 2nd July, 1936  | 19                                    | 33                                  | 62                    | Ditto                | 0"                 | 4"       | 3"        | Seeds too scarce to justify sowing in field conditions. |
| 22         | <i>Sterculia alata</i> .           | 1st July, 1936  | 13                                    | 43                                  | 50                    | ....                 | ..                 | ..       | ..        |   |

## BOMBAY.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

The Chief Conservator's office continued to control research work of general interest. Due to separation of Sind the subjects pertaining to it were transferred to the control of the Conservator of Forests, Sind.

During the year 5 new plots were laid out in the Poona division, 3 at Bhimashankar to study the problem of natural regeneration in evergreen forest and 2 near Poona for observing the effect of sheep grazing on tree regeneration in an area hitherto closed to sheep. Registers in the standard forms and allocation surveys have been prepared for these plots.

(ii) *Natural regeneration.*Sandal (*Santalum album*).

*Subject No. 28.*—Effect of early burning on sandalwood growth and regeneration (Belgaum division).

The 3rd remeasurements of the trees in each of the plots 28-A and 28-B were taken in December 1936. The trees were reclassified into 1" girth and 3' height classes with the following result:—

|                       |      |   |   | Plot A<br>(Fire protected). | Plot B<br>(Early burnt). |
|-----------------------|------|---|---|-----------------------------|--------------------------|
|                       |      |   |   | Average girth.              |                          |
| Original measurement, | 1933 | . | . | 4.97                        | 5.59                     |
| I. Remeasurement,     | 1934 | . | . | 5.60                        | 5.65                     |
| II. Do.               | 1935 | . | . | 5.63                        | 5.65                     |
| III. Do.              | 1936 | . | . | 5.93                        | 5.97                     |
|                       |      |   |   | Average height.             |                          |
| Original measurement  | .    | . | . | 12.12'                      | 12.27'                   |
| I. Remeasurement      | .    | . | . | 12.66'                      | 12.84'                   |
| II. Do.               | .    | . | . | 12.72'                      | 12.87'                   |
| III. Do.              | .    | . | . | 12.90'                      | 12.83'                   |

There is no significant difference in the average girth and height in both the plots. The leaders of 41 trees in plot A and of 35 trees in plot B are broken and this probably accounts for the poor average height. The Divisional Forest Officer reports that the only noticeable difference between the two plots is that natural regeneration is profuse in plot A while in plot B there is very little.

(v) *Artificial regeneration.**Hirda (Terminalia chebula).*

*Subject No. 37.*—Sowing and planting of *hirda* on laterite soil in the shade of existing shrubs or small trees (Poona and Satara divisions).

Out of the 60 seedlings and 66 transplants of *hirda* that survived at the end of last year in the 2 plots in the Poona division, 40 seedlings and 47 transplants are now surviving. The Divisional Forest Officer reports that the plants are sickly and have not put on much height growth. The average height of the plants is said to be about 6".

In the Satara division, *hirda* seed was sown in 100 pits (2 seeds in a pit) in laterite soil under the shade of bushes on the Mahableshwar plateau. Out of these only 27 germinated and 8 seedlings are surviving.

*Sandal (Santalum album).*

The Divisional Forest Officer, Belgaum, reports that tending of sandalwood plants raised in coupes 1 and 2 of Block XIX of Olmani, referred to in last year's report, was continued and that the plantation is in good condition.

The attempt made last year to raise *Bauhinia racemosa* on deserted village sites and fallow areas in the Tansa catchment area in the East Thana division as a means of minimising the danger from fire which is of annual occurrence in that locality, having proved impracticable on account of the heavy cost of weeding, the *rab* method of regeneration was tried during the year. Out of the several species sown on well burnt *rabs*, *Cassia siamea*, has shown the greatest promise of success as the plants have reached an average height of 3 feet 6 inches, look vigorous and are found to be immune to damage by browsing by wild animals. *Eugenia jambolana* and *Mangifera indica* are also promising though the latter are voraciously browsed by wild animals. It is intended not to do any elaborate weeding but merely to remove grass within a radius of 5' round the plants to minimise damage by fire.

*Tung trees (Aleurites fordii).*

Of the three surviving plants in the teak pole coupe of Block VI, Sambrani range in Kanara N. D. one died at the end of May and the other two are progressing satisfactorily. The height increment during the year is 13" in one case and 8" in the other

case. The plant at Tatwal which was 13" in height at the end of March 1935 has now attained a height of 20".

As the climate of the Haliyal Taluka is considered eminently suitable for this species a wet nursery has been prepared at Bomanhalli for further experiments and out of 396 seeds sown on 30th January, 77 germinated to end of March. The seed was sown 12" apart in raised unmanured beds and the present condition of the seedlings is fair. Germination commenced from the 26th of February and might possibly continue till 15th of April.

(vii) *Tending—Thinnings and cleanings.*

Teak (*Tectona grandis*).

*Subject No. 4.*—Effect of thinning on teak coppice at different ages (East Thana division).

In the East Thana division, 8 plots ranging from 8 to 15 years of age are under observation, the object being to find out the effect of thinning on teak coppice at different ages and the relative value of retaining one, two and three stems on each stool. Each of the above plots has been divided into two sub-plots (a) and (b). Sub-plot (a) has been left unthinned to serve as control plot and in sub-plot (b) one, two and three stems were respectively retained on stools bearing two, three and more than three shots.

Measurements of girth are to be recorded every two years and of height every ten years.

So far two remeasurements of girth have been recorded and the indications obtained are given below:—

- (1) The girth increment in the thinned plot is more than in the unthinned plot.
- (2) The crop thinned at 8 years of age, i.e., the youngest crop, has given the highest girth increment.
- (3) The girth increments put on by one, two and three stems left on a stool are:—

|                     |                 |
|---------------------|-----------------|
| 1 stem              | 23.61 per cent. |
| 2 stems             | 18.63 "         |
| 3 stems             | 17.25 "         |
| Control (all stems) | 12.89 "         |

Many more remeasurements of girth are required for obtaining reliable data.



*Subject No. 34.*—Effect of different degrees of thinnings in teak plantations (Kanara N. D., E. D. and W. D.).

The next remeasurement is due in 1940-41.

*Miscellaneous species.*

*Subject No. 16.*—Effect of improvement fellings on diameter growth (Dangs division).

The 3rd remeasurement was taken and recorded in December 1936. For the purpose of comparison, the percentages of increment in the 3 successive remeasurements are given below :—

|                                      | 1930. | 1933. | 1936.     | Mean. |
|--------------------------------------|-------|-------|-----------|-------|
|                                      |       |       | Per cent. |       |
| Plot No. 16-A (Improvement felled) . | 14.1  | 10.5  | 12.46     | 12.35 |
| Plot No. 16-B (Control) . . .        | 4.1   | 4.3   | 5.83      | 4.74  |

The above figures conclusively prove that the diameter growth in the improvement felled plot is considerably greater, *i.e.*, over 50 per cent. than that in the control plot.

The experiment is being continued.

(xi) *Miscellaneous.*

Sandal (*Santalum album*).

*Subject No. 7.*—Annual girth increment of sandal (Belgaum and Dharwar-Bijapur divisions).

The next remeasurements in plots 7AI to IV and 7BI and II are due in May 1937 and November 1938 respectively.

*Subject No. 32.*—Correlation existing between the outer girth increment and heartwood increment of sandal (Dharwar-Bijapur division).

The two plots were inspected by the Divisional Forest Officer, Working Plans, S. C., in February 1937 and found to have been maintained in good order. The next measurements and borings in these plots are due in 1938-39.

*Phenological observations on teak.*

Under instructions from the Silviculturist, Forest Research Institute, Dehra Dun, phenological observations were undertaken on sets of 5 trees in each of the Panch Mahals, North Khandesh, North Thana, East Khandesh, West Khandesh and Kanara Northern divisions. The trees selected in the North and East

Khandesh divisions had to be abandoned as they were badly attacked by defoliators and most of them bore neither flower nor fruit during the season. Copies of records of the trees in other Divisions were sent to the Silviculturist after the close of the year.

*Enterolobium timbouva* Mart.

A small quantity of seed of *Enterolobium timbouva* Mart, received from the Argentine Republic, was sown in boxes at Mahableshwar in July 1935 but none of the seeds germinated. In December 1935 the seeds were taken out and again sown, but in baskets this time. One month after this resowing one seed germinated and after a month and half 6 more seeds germinated. Out of these 7 seedlings, 3 were alive in December 1936 of which 2 subsequently died. The solitary surviving seedling is said to be vigorous, its height being about 25 inches.

*Eradication of prickly pear by cochini insects.*

The Divisional Forest Officer, Dharwar-Bijapur, reports that he noticed prickly pear coming up afresh in some places in the Badami and Bagalkot ranges where the killed material had not been burnt. It remains to be seen if this fresh crop will die out without the introduction again of the cochini insect. The existence of any old swarms in the locality has not been observed.

## II.—WORKING PLANS.

The following plans were sanctioned during the year:—

Working plan for the Satara forest division.

Working plan for the Satmalla forests, East Khandesh division.

Working plan for the Casuarina plantations of Kanara W. D.

## BURMA.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) *General.*

*Staff and programme of work.*—Mr. C. W. D. Kermode, Deputy Conservator of Forests, was in charge of the division throughout the year. Since the quinquennial programme of work was approved by the Chief Conservator of Forests, divisional forest officers have been submitting useful suggestions for silvicultural research into their local problems.

(ii) *Natural Regeneration.*

## (a) East Katha division.

*Dipterocarpus tuberculatus* (*in*).—Experimental plot No. 7 was laid out in 1922 to ascertain the effect of clear-felling on strips of various widths (1 to 3 chains) on regeneration existing at the time and on further recruitment. Half of each strip was fire protected and the other half burnt or left to nature. In the fire protected half there is now a dense regrowth of *Quercus* spp., *Lagerstroemia parviflora*, etc., and practically no *in*; while in the burnt strips there is now no regeneration in the 1-chain strip, a little in the 2-chain, and adequate (well on its way to establishment) in the 3-chain strip.

Experimental plot No. 9 was laid out to ascertain the results of burning, fire-protection and improvement fellings on the regeneration of *in* and *Pentacme suavis* (*ingyin*). The sub-plot, where improvement fellings were done in 1923 and since fire protected, has now an excellent pole crop of *in* as well as a fair number of established *Pentacme* regeneration; the one similarly worked (under improvement fellings) but burnt annually since 1923, has also a lot of *in* regeneration with abundant *Wendlandia*. Where no such fellings were done, the pole crop of *in* regeneration was much less with a few *Pentacme*, mixed with other species under a dense overwood in the fire protected area, and some established *in* regeneration with localised patches of unestablished *Pentacme* in the annually burnt area. The sub-plots gave indications that whereas fire-protection is beneficial to the growth of *in* regeneration, it is not essential, and that *Pentacme* which needs fire-protection for establishment has not much chance to hold its own in competition with *in*.

Experimental plots Nos. 12-19, laid out in 1925 to study the effect of different degrees of opening the overwood on the regeneration of *in* (*Dipterocarpus tuberculatus*), were not worked out to prescriptions. Instead E. P. Nos. 29 to 31 (A & B) were laid out in 1933-34 with the following treatments and results to date:—

| E. P. No. | Initial condition.      | No. of seedlings at formation (per acre). | Treatment.                  | No. of seedlings in February 1937 (per acre) |
|-----------|-------------------------|---|-----------------------------|--|
| 29        | Regeneration sufficient | 5,090                                     | Complete removal of canopy. | 3,998  |
| 30        | " insufficient          | 420                                       | Light opening of canopy.    | 483  |
| 31 (A)    | " 50%                   | 2,623                                     | Complete opening of canopy. | 2,415  |
| 31 (B)    | " Scanty                | 1,725                                     | Ditto                       | 1,428  |

The method of enumeration by stocked squares has recently been introduced which will show hereafter the progress of regeneration in a more systematic way.

Experimental plots Nos. 20-25, with the general object of ascertaining whether regeneration of *in* in areas with a fairly dense overwood could be induced by hoeing or burning the grass before seed-fall, indicated that after a steady progressive increase extending over 8 years (from 1926-33) there has been a falling off in the amount of regeneration since 1933 without any sign of progress towards establishment.

(b) Zigon division.

*Dipterocarpus tuberculatus* (*in*).—The experimental plot No. 4, laid out in 1927, to study the effect of clearfelling over existing regeneration of *in* has shown a steady progress towards establishment of seedlings. There are now 781 established (10 feet and over in height) *in*, 32 *pyinkado* (*Xylia dolabriformis*) besides 196 other associate species on one acre, fairly well distributed over the area.

*Pentacme suavis* (*ingyin*).—In experimental plots Nos. 1-8, in an evergreen type of forest in Myitkyina division, different treatments were given to the canopy, from cleaning of undergrowth to removal of all overwood except seed bearers, with and without burning, without any appreciable difference in results so far. The absence of natural regeneration of any size is remarkable. The experimental plots Nos. 9-11, to study the effect of soil working and broadcasting seed, resulted in very moderate germination but rapid dying off,—leaving only 5 seedlings in three plots.

(c) Dry upper mixed deciduous forests in the Shwebo division.

Experimental plots Nos. 1 to 10 were formed in 1926-27 (and 11 to 15 in 1934) with the object of finding out if regeneration could be improved by preparatory fellings which included the felling of bamboo clumps. The general condition at present is that the felled bamboo has completely recovered and in practically all cases, there is now a heavy growth of bamboos densely covering the ground, and *Eupatorium odoratum* which had made its appearance in some places has now disappeared almost completely. Absence of control plots may not render results definitely attributable to treatments, but the following indications are worth noting:—

*Teak*.—The opening out brought in fresh recruitment of seedlings and the stock increased till 1929, but thereafter it gradually

tended to decrease. There are now 10 to 70 established teak plants per acre in every experimental plot.

*Xylia dolabriformis* (*pyinkado*).—Regeneration of this species is very low and its seed bearers are very few in the plots.

*Pterocarpus macrocarpus* (*padauk*).—There is a small amount of its regeneration in all plots, although like teak it started reasonably and continued well up to 1929. There is no sign of its establishment, only 3 trees in 10 plots have passed 15 ft.

*Shorea obtusa* (*thitya*) and *Pentacme suavis* (*ingyin*).—The experiment started with abundant regeneration in four plots and the 1933 counts showed an increase in all—profusely so in two. Most of their regeneration died off later and not a single plant has reached establishment height yet.

*Terminalia tomentosa* (*taukkyan*).—A fair amount of regeneration appeared after the original cleaning of bamboo, especially in 1928-29. It soon disappeared and the species seem to be intolerant of shade in early years in these dry forests.

Other semi-important species have also been kept under observation. Regeneration of all except *pyinma* (*Lagerstroemia* spp.) appeared in abundance in some of the plots, subsequently disappearing in most cases.

#### (d) Evergreen forests.

*Heritiera minor* (*kanazo*).—A series of plots (Nos. 1 to 5, Delta division) was laid out in 1934 in *Heritiera* forest with the object of ascertaining if there was any significant ( $\pm 30$  per cent.) alteration in quantity of *Heritiera* or other species due to (a) heavy opening of canopy and understorey by extraction and (b) light opening of the canopy and admittance of side light by fellings. Results so far are not conclusive. Except in one plot, heavily opened, there is a general increase of regeneration in all other plots. A marked difference is noticeable so far between a plot lightly opened and an untouched control plot, the former showing an increase of 70.7 per cent. while the latter only 5 per cent.

#### (iii) Artificial Regeneration.

##### A.—Experiments with teak stumps.

*Stump planting versus direct sowing and entire transplanting.*—The 1934 stump experiments, reported on last year, were remeasured during the year. The measurements confirmed last year's results

that the advantage of planting stumps begins to be lost in the 3rd year as would appear from the following tabular statement:—

| Centre.         | Method.                       | Growth put on |           |           | Total height. |
|-----------------|-------------------------------|---------------|-----------|-----------|---------------|
|                 |                               | 1st year.     | 2nd year. | 3rd year. |               |
| Myohla          | Stumps, (31-5-34)             | 2.8           | 5.8       | 2.0       | 10.6          |
|                 | Direct sowing (28-4-34)       | 1.1           | 4.3       | 2.4       | 7.8           |
| Myohla          | Stumps, (31-5-34)             | 2.1           | 8.9       | 3.8       | 14.8          |
|                 | Direct sowing (28-4-34)       | 0.8           | 4.7       | 3.8       | 9.3           |
| Nyaungbian-zin. | Stumps, (25-5-34)             | 2.9           | 4.7       | 2.3       | 9.9           |
|                 | Nursery seedlings (17-6-34)   | 1.6           | 3.8       | 2.7       | 8.0           |
| Xyunchaung      | Stumps, (25-5-34)             | 2.8           | 12.7      | 9.2       | 24.7          |
|                 | Seeds sown at stake (29-4-34) | 1.3           | 8.9       | 11.0      | 22.1          |

*Early (pre-monsoon) planting of stumps.*—The 1935 plots were also remeasured at the close of the 1936 growing season. The two successive measurements shew that in the Ataran centres as well as at Sintesakan where the rainfall is high (about 200" and 95" respectively), the advantage of early planting before rains break is maintained in the 2nd year. The early planted stumps did better both in growth and survival when protected by piling loose earth on top. In places where the rainfall was below 60" percentages of survivals of early planting were low even when protected with earth. The indications are that it would be unsafe to recommend very early planting of stumps in areas of less than 100" annual rainfall, though if protected with a covering of loose earth, they can probably be planted in areas with rainfall as low as 60".

*Stump-planting at the break of rains and at 1, 2 and 3 weeks later.*—Experiments in planting of stumps after the break of rains mentioned last year, were maintained and remeasured. Results indicate that the advantages recorded last year of planting stumps upto a fortnight after the break of rains over the divisional methods of transplanting seedlings have been maintained in the 2nd year.

*Stump-root-length.*—The stump root length experiment, reported on last year, was remeasured and results tabulated. In the 1934 experiment the effect of different root lengths varying from 6" to 10" appears to be very slight—the 10" ones being slightly better than the rest. The 1935 experiments also do not lead to any new conclusion, and there seems no reason to depart from the opinion that stumps with root lengths between 4" and 8" are all likely to give good results.

*Patching experiment.*—At Sintesakan (Insein), very little difference was noted in the mean height of survivals of stumps and seedlings. Survival of seedlings was, however much better than stumps except stumps planted immediately at the break of rains. At Kunsan (Zigon) stumps put out at the break of rains and up to a fortnight thereafter shew a marked superiority to seedlings both in height growth as well as in the percentage of survival.

*Coppice experiment.*—The coppicing experiment of last year was remeasured. Results indicated that it would be of no advantage to coppice seedlings or stump-plants at the end of their first season's growth. The past practice of burning over new *taungyas* at the end of the first year and coppicing back seedlings might not, therefore, be a good policy.

### B.—Regeneration of *Pentacme suavis* (ingyin).

Experimental plots Nos. 14-17 in the Shwegu reserve, Bhamo division, were examined with the results as tabulated below:—

| Plot No.                  | Treatment.                      | No. of <i>ingyin</i> plants per acre. |                   |        |
|---------------------------|---------------------------------|---------------------------------------|-------------------|--------|
|                           |                                 | Unestab-<br>lished.                   | Estab-<br>lished. | Total. |
| (Over 10' in height.)     |                                 |                                       |                   |        |
| 14 Sown in hood<br>lines. | (i) Weeded and burnt . .        | 364                                   | 588               | 952    |
|                           | (ii) Weeded and protected . .   | 260                                   | 1014              | 1304   |
|                           | (iii) Unweeded and burnt . .    | 970                                   | 84                | 1060   |
|                           | (iv) Unweeded and protected . . | 536                                   | 200               | 736    |
| 15 Dibbled at<br>stake.   | (i) Weeded and burnt . .        | 330                                   | 580               | 916    |
|                           | (ii) Weeded and protected . .   | 100                                   | 736               | 836    |
|                           | (iii) Unweeded and burnt . .    | 1188                                  | 16                | 1201   |
|                           | (iv) Unweeded and protected . . | 504                                   | 356               | 860    |
| 16 Seed broad-<br>cast.   | (i) Weeded and burnt . .        | 864                                   | 64                | 928    |
|                           | (ii) Weeded and protected . .   | 336                                   | 220               | 556    |
|                           | (iii) Unweeded and burnt . .    | 552                                   | ..                | 552    |
|                           | (iv) Unweeded and protected . . | 368                                   | 40                | 408    |
| 17 Transplants .          | (i) Weeded and burnt . .        | 1072                                  | 44                | 2016   |
|                           | (ii) Weeded and protected . .   | 202                                   | 494               | 776    |
|                           | (iii) Unweeded and burnt . .    | 1496                                  | 352               | 1848   |
|                           | (iv) Unweeded and protected . . | 444                                   | 96                | 540    |

It would appear that though fire protection is not essential provided that weeding is carried out; it has a marked influence on the crop, in that the fire protected plot shows a larger number of established plants than the burnt one. The figures also show that a reasonable amount of establishment can be got if weeding is done even though fire protection is not given. Success can be obtained either by dibbling or by sowing in hoed lines.

(iv) *Mixtures (in plantations).*

An experimental plot was laid out in a 1935 plantation in Zigon division to study the growth of teak and *pyinkado* (*Xylia dolabriformis*) in mixture. The latter was sown 6' x 6' over the whole area and one year old teak stumps were then planted in groups 6' x 6', the centres of groups being 30' apart. The teak now stands out conspicuously in little islands above the *pyinkado*. The table below shows the height growth of both species. Heights are in inches and decimals:—

| Date of measurement.<br>1 | Teak.                    |                                | Pyinkado.                |                                |
|---------------------------|--------------------------|--------------------------------|--------------------------|--------------------------------|
|                           | Percentage success.<br>2 | Average height survivals.<br>3 | Percentage success.<br>4 | Average height survivals.<br>5 |
| 21-3-31 . . . .           | 99%                      | 40.4                           | 96%                      | 11.4                           |
| 2-12-36 . . . .           | 91.4%                    | 97.7                           | 89.7%                    | 39.2                           |

(v) *Regeneration of teak in areas where Bombusa polymorpha flowered gregariously.*

A large number of experimental plots (71 in all) were laid out in Pyinmana and North Toungoo division in areas where *kyathing* bamboo (*B. polymorpha*) had flowered during 1935-36, with the object of producing a reasonable crop of young teak in the wake of the disappearance of bamboo growth. The plots laid out can be divided into 2 broad groups,—(1) experiments with stumps and (2) experiments with seed—each subdivided into a number of treatments, viz., planting at different times before or after rains break in the case of (1), and broadcasting, dibbling or patch sowing in the case of (2). All experiments were repeated both on level ground and slopes with different densities or espacements. Results to date are summarised below:—

*Early stump planting.*—Planted in the first week of May, percentages of survival were 60 at one place and 88 in the other with



mean heights ranging from 10·2" to 16" and 6·6" to 14" respectively.

*Stumps planted at break of rains.*—Percentages of survival were 86 at one place and 36 in the other, with mean heights ranging from 8·3" to 1·5" and 6·6" to 7·3" respectively.

*Late stump-planting.*—Planted in the 2nd week of June, percentages of survivals were 66 and 62 with mean heights ranging from 7·3" to 8" and 6·1" and 8" respectively.

Abundant weed growth appeared almost everywhere.

*Ordinary broadcasting.*—Seed was spread out as evenly as possible over the whole plot. Seedlings were counted on indicator lines, run across the plot, but very few seedlings were noticed.

*Patch broadcast.*—The seed, instead of being scattered, was laid down uniformly in small heaps at about 50 per acre. Results were very slightly more successful than ordinary broadcasting.

*Dibbling.*—Seeds were dibbled at 4 to 6 seeds per stake, without much success.

In fact in so far as one year's results indicate in all cases of experiments with seed, results have been a failure for all practical purposes; whereas stump planting gave some positive results that are admittedly superior to direct sowing both as regards percentage of survival as well as height growth.

(vi) *Investigation of the influence of seed origin in the case of teak.*

This investigation has continued for several years. Further sowings were done during the year in Zigon division. Seed of Travancore, Nilambur, Zigon, Khandesh and Mysore origins were tried. Khandesh seed was a complete failure. Casualties in the Nilambur, Zigon and Mysore plots were also very heavy. The old 1931 areas in Zigon and Myitkyina divisions were found to be so poorly stocked that no sample plots could possibly be laid out. In Myitkyina, attacks by *Haplohammus* on trees of Indian seed origin were noticed to be much more serious than on trees of Burma seed origin.

## II.—WORKING PLANS AND STATISTICS.

### (i) *Working Plans.*

Four working plans were sanctioned during the year, viz., for a portion of Bhamo (Kaukkwe), North Pegu, Northern Shan States, and Thaton divisions. Work was also in progress on 19 other

divisional plans of which 9 were nearing completion. Necessary additions to and modifications of sanctioned working plans were also carried out during the year which included thinning and cleaning schemes for plantations and felling-cum-regeneration schemes elsewhere.

Some field work has been done in connection with stock mapping and estimating stock in the various types of forest in Zigon, Insein, Thaton and Upper Chindwin divisions. In the case of teak, enumeration of the stock is being done gradually at the time of girdling and complete figures will not be available for some years. Extensive forest surveys were carried out by different parties of the Survey of India during the year. Besides, local surveys were made by forest subordinates in different circles.

#### (ii) *Yield, Volume and Form Factor Tables.*

Two new volume increment plots in teak and *pyinkado* (*Xylia dolabriformis*) were found and 92 existing sample plots were re-measured during the year.

Enough material has been collected for the preparation (by the Forest Research Institute, Dehra Dnn) of yield tables for plantation teak in Burma.

An attempt has been made to determine the rate of growth of the three important species—viz., *Sterculia campanulata*, *Bombax insignis*, and *Anthocephalus cadamba*—constituting the *matchwood sample plots* in Insein division. The figures indicate so far that in a closed forest and growing in competition with other trees, growth of matchwood species is not very fast, as is often thought. Between themselves *Anthocephalus* is the most quick growing taking about 40 years to attain a breast height girth of 4 ft., *Bombax* next, requiring 70 years and *Sterculia* about 85 years to attain the same girth.

Girth increments of miscellaneous species have been worked out, also diameter increments of a large number of *teak* and *pyinkado* for the ten year period. The latter indicate an average annual diameter increment of 0.189" for *teak* and 0.157" for *pyinkado*.

#### (iii) *Statistical Research in Irregular Crops.*

Crown space measurements collected in the two plots laid out last year were examined and statistical analysis shewed that two measurements of the crown at right angles were necessary for accuracy as single measurements led to under estimating. Some figures for ring counts of *teak* were received from divisions and worked out during the year.

## CENTRAL PROVINCES.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

1. A triennial programme of silvicultural research for the years 1936-39 was drawn up in consultation with the Central Silviculturist and approved by the Chief Conservator.

2. It is the policy to obtain natural regeneration following suitable fellings dictated by experience.

3. In certain forests, however, restocking by artificial means has had to be resorted to for special reasons. The high forests of Allapilli and Moharli, where natural regeneration is almost impracticable due to prolific regrowth of bamboos and weeds are being restocked by stump planting with teak. Plantation work is being extended to convert the good quality mixed forests of Bilaspur to teak forests. The very open and heavily grazed forests of Yeotmal and West Berar, deficient in seedling and coppice reproduction, are being regenerated artificially by the agri-silvicultural method, which has proved so successful in these tracts.

Elsewhere plantation work is being carried out on a very small scale as an experimental measure only.

4. The following is a summary of observations of silvicultural interest from divisional reports:—

*Amraoti.*—In the conversion working circle with mature or overmature overwood there is a lack of advance growth of teak. A very small proportion of seed is fertile, which probably accounts for the paucity of seedling regeneration; coppice reproduction is also very poor. These, in clear-felled areas, soon get swamped by a rank growth of *Heteropogon ritchiei*. *Ougenia dalbergioides*, however, is reproducing freely both from seed as well as from coppice.

*Balaghat.*—In sal forests, establishment of regeneration is largely affected by deer; and the occurrence of blanks is due to adverse edaphic and climatic conditions. Provided that adequate frost protection is assured the progress of established regeneration is dependent on the amount of light admitted to the forest floor.

*Bhandara.*—In the mixed forests the proportion of teak is gradually increasing (even when no apparent gaps in the canopy are created) due to overhead shade and light grazing.

*North Chanda.*—Heavy undergrowth of bamboos, following a clear felling, has been mainly responsible for the poor regeneration in the better quality forests. As a result of observations in Experimental Plot No. 6 and elsewhere, a method out of the difficulty now seems to have been found. Bamboos are now to be cut back in -10, -3, 0 and +1 years counting from the year of main felling to induce and foster teak reproduction.

*West Betar.*—The main problem is the best method of working the *anjun* (*Hardwickia binata*) forests. This species is a poor seed bearer, and seed years occur only once in 5 or 6 years. The leaves are much browsed by cattle to the detriment of regeneration. Measures to restrict grazing during the three years preceding the final felling, to run a light fire and to work up the soil; and after the felling, to completely close the area to grazing for a period of 7 years have been recommended to foster reproduction.

(ii) *Natural regeneration including coppice and root suckers.*

5. Due to abnormally heavy monsoon rains and frequent showers throughout the winter and the early part of the hot weather, the trees had a longer period of vegetative activity and most of the species, especially teak, burst into new foliage about two months earlier than usual. Intense heat towards the end of the hot weather, therefore, had a distinctly harmful effect, as most of the young leaves and even leaf buds were killed.

6. The following observations are reported from divisions:—

*Hoshangabad.*—A fair amount of established natural reproduction of teak is common in all the maturing or mature forests, except in places with long grass, or a dense under-growth of bamboos. The coppice regrowth is very rapid—35' high and 18" girth in 8 years—especially from stools under 2' in girth. Bigger stools have produced more numerous but weak and malformed shoots. In recently regenerated areas *Kydia calycina* has come up in great profusion which may very soon interfere with the teak.

*Nagpur-Wardha.*—Coppice reproduction of teak in almost all the areas worked recently under coppice with reserves or conversion is satisfactory but seedling regeneration is lacking, due to the rank growth of grass following clear fellings. On the other hand, in areas worked under thinnings in the past, the forest floor is covered with vigorous and thick advance growth, particularly of teak. This is due to the opening up of the cover combined with fire-protection and regulated grazing which encourage natural regeneration from seed by keeping back the rank growth of grass and

weeds. The thinnings carried out in the past were a bit drastic as they combined improvement fellings with a cutting back of bad growth, but they have done immense good to the forest by inducing seedling regeneration and invasion of teak into areas where there was no teak reproduction.

*Nimar*.—Natural regeneration of teak is excellent wherever the soil is of sufficient depth, the drainage is satisfactory and the grazing is moderate. In the forests on the Vindhyan sandstones, teak is the most aggressive species and a progressive succession by natural regeneration has already reached the climax over most of the areas. Most of the forests are dense and the proportion of teak, which is already high, is fast increasing. Everywhere, a pole crop of teak is most noticeable and the invasion of teak into almost pure *Boswellia* or *Hardwickia* forests very marked, although the best regeneration is mostly confined to the valleys leading into the Nerbudda.

In the trap forests also, natural regeneration of teak is satisfactory but wherever grazing is insufficient, it is not so good owing to the presence of tall grass. In forests where moderate grazing tends to keep down the grass, it is splendid, while teak regeneration is particularly absent wherever grazing is excessive.

*Icotmal*.—In the teak forests on trap, prolonged closure to grazing does not help teak reproduction. The grass reserves that have remained closed to grazing for over 20 years have not filled up with tree growth so well as similar areas that have been open to grazing for 5 years after a 10-year closure. Moderate grazing helps regeneration everywhere and even heavy grazing does not adversely affect regeneration on plateaux and hill slopes strewn with trap boulders, but it impoverishes the soil and lowers the quality of the forest. The presence of miscellaneous species, particularly on poorer soils, is helpful to teak reproduction and also improves the quality of the locality.

7. In the mixed forests of Nagpur-Wardha there is a lot of teak reproduction in the thinned areas and more and more is coming up. But at the same time this rapid colonisation of these forests by teak is not confined to the thinned areas but occurs throughout the forests, wherever the factors of locality are favourable. Teak reproduction was found to have been scanty in 1895, but increased considerably since, as noticeable in 1925, till at present these forests contain extensive areas with 5 to 50 per cent. teak in them, the bulk of which is young to middle aged, and what is, even more remarkable consists of all sizes inextricably.

mixed as in a selection forest. These patches are rapidly extending with increased proportion of teak in them. The progress from a mixed forest (of the pre-reservation period) towards a seral teak forest appears to be due to radically altered ecological factors resulting from protective measures of conservancy and regulated methods of treatment. Generally this invasion by teak starts from areas where conditions of soil moisture tend to improve due to cessation of soil run-off, accumulation of decomposed leaf mould, and a gradual closing up of the canopy, which were not possible under pre-reservation conditions. The most typical instances are the areas under *Boswellia serrata* and *Madhuca latifolia* trees which have been left standing (without being destructively exploited) in the past. Other conditions being favourable, invariably the shade of these trees helps the teak to establish itself.

8. *Root-suckers*.—*Diospyros melanoxylon* is regenerating profusely by root-suckers everywhere, especially in the *maidans* in the sal forests near Kisli. Its tendency to regenerate by root-suckers in areas where its leaves are collected is a great advantage, as the leaves from the suckers are of a better quality for making *bidis* and can also be picked easily.

### (iii) *Seeds*.

9. *Seeding*.—It was a poor seed year for teak, which is attributed to a heavy attack of defoliators. Sal and *Hardwickia binata* seeded well; *Dendrocalamus strictus* seeded sporadically as usual; for other species it was a normal seed year.

10. As usual the Silviculturist acted as the distributing agency for seed, both inside and outside the province.

### (iv) *Nursery Work*.

11. The most important nurseries of the province are at Talwara (South Chanda), Deopur (Bilaspur), Balaghat Forest School, Umerda (Yeotmal) and Khadki (West Berar). The following interesting observations are reported:

*Deopur*.—The *dona* (leaf cup) system was evolved and perfected in this nursery. Though silviculturally ideal the method is becoming unpopular in practice, because when planting operations are undertaken on a large scale the forest villagers, in their hurry shove the plants into the *donas* carelessly; and the deformed root system caused thereby does not allow the plants to develop properly. The amount of care necessary to avoid this, and the watering for two months on covered platforms are costly. Transport of

*donas* is also difficult and expensive. The system is, therefore, gradually being replaced by stump planting.

*Balaghat Forest School.*—An effective and cheap means of weathering teak seed is to spread it on bambóo matting placed on bamboo platforms, about 18" above the ground, with the edges of the matting turned upwards so as to secure a slight sag in the centre to prevent the seed from being knocked down in a storm. It is important not to spread the seed more than 2 inches thick.

Few casualties occur among teak seedlings raised in *donas* provided  $\frac{2}{3}$  good loam and  $\frac{1}{3}$  manure is used. The *dona* method is particularly suited to the delicate seedlings of *Dalbergia latifolia*.

*Umerda.*—6,834 *Bambusa polymorpha* and 970 *Dendrocalamus strictus* seedlings from this nursery were transplanted over 100 acres in 18" x 18" x 18" pits towards the end of June 1936. In February, 40 per cent. of the plants were alive and doing well. The total cost including preparation of pits, transplanting, and mulching was 8 pies per plant. No weeding was required during the rains. Casualties were highest among the smaller seedlings and those planted on flat ground, or on stiff soil. Plants along slopes and under shade developed best. *Dendrocalamus strictus* seed was sown on 175 beds, 6' x 3', on 7th/9th July 1936. Line sowings gave better results than broadcasting, but heavy casualties were caused by hares. At the close of the year the seedlings were 9 to 24 inches high.

*Ornamental Tree Nursery.*—A small nursery has been started at Nagpur, where seeds of various arboricultural species were sown in June 1937.

#### (v) Artificial Regeneration including agri-silviculture.

##### (a) Plantations.

12. Clear felling followed by artificial stocking with teak was started in 1933. These operations constitute the first large scale plantation work undertaken in the province. The spacing throughout has been 12' x 12' and 717 acres were planted up during the last 4 years (at about 180 acres per annum). The cost per acre has worked out at Rs. 6-6-0 on the average, exclusive of cost of fellings.

Experience in these plantations shows that stumps are preferable to *donas* and that the best results are obtained by planting stumps from 0.8 to 1.9 inch diameter at the collar. Early weedings in July and August are essential but need not be repeated

in the second year when all that is needed is to cut the herbaceous climbers and the overhanging culms of bamboos. Early planting reduces costs of weeding.

With a view to effect further economy various experiments are in progress, *viz.*, pre-monsoon planting in prepared pits; ball planting; stump planting under the mature wood 5 years in advance of main fellings; 6' x 6' and 9' x 9' espacement, etc.

13. *Balaghat*.—In the school forest, 8 acres were cleared and planted up 6'6" x 6'6", *i.e.*, exactly 1,000 plants per acre, with teak plants raised in *donas* alternating with miscellaneous species in single lines without any soil preparation, with a view to see if soil preparation could be dispensed with. Plants were weeded twice during the rains. A slight reduction in height growth was observed but no appreciable increase in casualties.

*Eucalyptus donas* planted over 2 acres also without soil preparation were 15" high at the end of the year; and nearly 75 per cent. of the plants survived.

2,000 teak *donas* were planted under the light shade of miscellaneous species. No weeding was done, nor was the area closed to grazing which is quite heavy. 50 per cent. of the plants were alive at the end of the hot weather.

14. *Raipur*.—The small teak plantations were extended and the regrowth from the plantations damaged by frost in 1936 withstood this year's frost.

15. *Bilaspur*.—43 acres were planted up (in different compartments) with mostly teak, *donas* and stumps from forest seedlings along with a few *Dalbergia latifolia* and mahogany. Results were generally satisfactory except in one compartment where the frost in January caused many casualties. The approximate cost excluding expenses on felling but including cost of raising plants and replacement of casualties worked out at Rs. 5 per acre. To reduce costs, and to encourage the coppice regrowth from miscellaneous species which protect the soil against insolation, the teak was planted with a spacing of 12' x 12' instead of 6' x 6' which had been the practice hitherto.

#### (b) Agri-silviculture:

16. *Melghat*.—About 300 acres of forest badly infested with *Lantana* were given over to forest villagers (for a period of 4 years)



for the uprooting of *Lantana* and cultivation of field crops combined with sowing of seeds of miscellaneous tree species.

17. *Yeotmal*.—(i) *Kinwat departmental operations*.—34 acres of moderately stocked mixed forest of C. P. III quality, were clear felled in January 1936. The cut material was piled over the large stumps and burnt in the hot weather. After cross ploughing and harrowing the area was sown in the last week of May with treated teak seed, in lines 6 feet apart. Germination started on 22nd June and was very satisfactory. Between the teak lines, cotton was sown in lines 2 feet apart in the last week of June. The teak lines were weeded in July and again in August. The cotton crop was ruined by late rains, and the frost in January took a heavy toll of the teak seedlings. The plantation is, however, slowly recovering. Better results were obtained in 1936, but wherever stumps were introduced two years ago, the results have been more satisfactory. *Acacia catechu* was sown in 8 plots towards the end of June and germination was excellent. Teak seedlings were transplanted from the nursery to fill up blanks in the lines.

(ii) *Borwadi*.—18 plots. An area of 0.5 acre in each plot was selected in February 1936 in which all stumps were uprooted and the area thoroughly ploughed in March. Dry wood from the adjoining forest was piled on the site and burnt in May. Teak seed was sown in lines 6' apart on 23rd May and germination commenced on 22nd June and was very complete; one year old teak seed stored in white ant hills for about a month giving the best results. The few gaps were filled up by transplanting seedlings from last year's plots. The tenants sowed chillies and tobacco between the lines. The lines were weeded in July and again in August. In the first week of January a mild frost occurred which killed the shoots of some of the seedlings; these however sprouted later. During the last three years, 27 acres have thus been more or less successfully regenerated. The following measurements were recorded in March 1937:—

| Year of plantation. | Height.  |          |
|---------------------|----------|----------|
|                     | Maximum. | Minimum. |
| 1934 . . . . .      | 16'      | 10'      |
| 1935 . . . . .      | 10'      | 6'       |
| 1936 . . . . .      | 2.5'     | 1.3'     |

18. *West Berar*.—Every year one coupe of 30 acres in each felling series is leased out for a period of 5 years for agri-silvi-

culture. In the first and second year only field crops are raised. In the third year *babul* seed is sown in lines 15' apart along with field crops, which are repeated in the last two years. The lessee is to sow the seed supplied by the Department, weed the seedlings, replace casualties, and in every way foster the plants during the last 3 years of his lease. If he fails to tend the lines, the work is done departmentally and the costs recovered. Most of the *babul* forests of Berar have been regenerated in this manner during the past 30 years, but experience has shown that pure woods of this species are very prone to fungal and insect attack. Recent management has therefore been directed to the introduction of a mixture of other species, of which the most suitable appear to be *Gmelina arborea*, *Pongamia glabra*, *Albizia lebbek*, *Dalbergia sissoo* and *Prosopis juliflora*.

### (c) Experiments.

19. *Regeneration from root-suckers.*—*Bombax malabaricum*. Innumerable seedlings come up in the rains under the older trees, but soon perish either from suppression or damage by wild animals. An experiment has therefore been started in South Chanda to determine the best method of establishing these seedlings. In a selected area, securely fenced against deer and pig, the overwood which consisted of miscellaneous species with a good proportion of *Bombax*, was heavily opened, all bamboos cut back, and the debris removed. In the rains of 1936 nearly 2,000 seedlings came up over an area of 1 acre. In February most of these were alive and had developed carrot-like roots about 75 inches diameter and 6 inches long. Their progress is being watched.

Experiments have also been started to study the possibility of obtaining regeneration from suckers by wounding the roots of standing as well as recently felled trees (*vide* article by Mr. Holland in the *Indian Forester* of December 1936).

Attempts are also being made to raise crops artificially by stump planting.

### (vi) Reclamation, afforestation and arboriculture.

20. *Arboriculture.*—138 pits 2' x 2' and 3' deep were dug on the rocky ground (in the compound of Kolsa Forest Rest House), filled with forest soil and fenced with bamboo mats. *Swietenia macrophylla* and *Eucalyptus citriodora* seeds were sown. The pits

were watered daily and although the seeds germinated well, about 10 per cent. casualties occurred due to attacks by white ants.

The camping ground in the Nagpur Civil Station was cleaned by the Nagpur Municipality and one year old seedlings of ornamental species were planted in prepared pits, 3' diameter and 5' deep, in suitable groves and glades under the supervision of the Silviculturist.

*Hoshangabad.*—Little is known about the correct intensity of thinning for young forests. Three typical coupes, regenerated in 1928, were selected and thinned to ascertain whether it would be possible to lay down roughly the number of stems per acre which should be left and to carry out the first thinning mechanically. The operations showed that while this can be done it is not desirable and that the thinning should be carried out according to the silvicultural requirements of the individual stems, as the crop varies considerably even within a very limited compass.

*Betul.*—Experience suggests that cleanings should not usually be delayed beyond about the fourth year. In reasonably accessible coupes it has been found that generally the price realised by the sale of the produce more than covers the cost of the operations.

*Balaghat.*—The original spacing of 6' × 6' of the 1930 plantation in the School forest was reduced in 1935 to 8½' × 8½' by mechanical thinnings when alternate diagonals were removed. Before thinning, the crop was said to be very congested and lack of space at the top is said to have caused development of branches lower down, a fact which was not recognised at first.

21. No definite scheme for thinning has been laid down as yet but an earnest attempt is being made to determine the optimum thinning regime suitable to our special conditions.

22. *Sal.*—It is now recognised that the first thinning in sal should be at 5 years of age and frequent thinnings carried out before the trees close up—as they appear to do after 30 or 40 years, to produce the typical “gummed up” effect. A start was, therefore, made in the earliest coupes of the Blue Block (Balaghat) where pruning of double leaders with the aid of light ladders, freeing from climbers, thinning out to give growing space all round was done to the great improvement of the dense coppice regrowth resulting from regeneration fellings.

23. *Babul.*—This is a strong light demander and heavy cleaning in the earlier stages and after about the middle of the rotation are essential, as, otherwise the trees fall victims to disease. The optimum espacement is to just free the crowns of adjacent trees.

(vii) *Climbers and Weeds.*

24. *Bauhinia vahlii*.—In Amraoti this climber was dug out over an area of 40 acres and unweathered teak seed dibbled in the holes at a cost of Rs. 1-8 per acre. This resulted in the climber being exterminated wherever the operation was thorough, but the teak seed failed to germinate. In Balaghat the method (found successful in Seoni division) of cutting the climber 6" below ground level and ramming earth on the stump, has now been introduced. In Nagpur-Wardha also two  $\frac{1}{2}$  acre plots have been laid out where climbers were similarly cut and rammed, in March,—one in a fully stocked area, and the other in a similar forest recently felled under improvement felling-cum-thinnings.

25. *Lantana aculeata*.—In Amraoti eradication over 34 acres cost Rs. 1-13 per acre. In the Melghat, *Lantana* was pulled up with the help of elephants in the rains, and burnt in the hot weather, a year in advance of the main fellings, over an area of 5,723 acres at a cost of Rs. 4,235.

26. *Dendrocalamus strictus*.—In the better quality forests of North Chanda bamboo regrowth is the main obstacle in the way of teak regeneration. As however bamboos are marketable and protect the soil it is not desirable to exterminate them.

(viii) *Mixtures.*

27. Due regard is being paid to the prescriptions in the working plans to favour the already aggressive teak over mixed species or to maintain a mixed crop for future according as local conditions would permit. In North Chanda the 1936 plan lays down that a mixture must be aimed at in the naturally as well as artificially raised crops. Accordingly in plantations teak is mixed with *Pterocarpus*, *Albizia lebbek*, *Dalbergia sissoo*, *Gmelina* and *Morus alba* as an experiment, these species being planted in several consecutive rows. In Jubbulpore a patch of forest was discovered where teak and sal are growing together on black cotton soil. Examples of the two species growing together on sandy loam are common but not on trap.

(ix) *Underplanting.*

28. *North Chanda Experimental Plot No. 8 (1935)*.—The object is to observe the progress of teak stumps under a complete canopy of mixed forest, with an understorey of bamboos. The ultimate aim is to get sufficient vigorous teak plants established cheaply and with as little tending as possible, so that when the overwood is felled, and

the teak cut back the resulting coppice will outgrow the weeds and bamboo regrowth without any tending.

Stumps from previous year's forest seedlings were put out 9' x 9' in the rains of 1935. Casualties mostly due to white ant attack were 95.4 per cent. These were replaced by one year old nursery stumps in June 1936. Casualties after one month were 13 per cent., all of which were replaced. In February 1937, almost all the plants were alive and 4 to 6 inches in height with 2 to 4 leaves that were just beginning to turn grey.

29. *South Chanda*.—Similar experiments have been started to ascertain whether stump planting with teak, 5 years ahead of the main fellings in P. B. I. areas is more economical than burning and planting after fellings. Three treatments are under observation, viz., planting under (i) dense overwood and bamboo, (ii) light overwood and grass, and (iii) open overwood. Stumps were put out 12' x 12' on 2nd June 1936.

30. *Bilaspur*.—In an area planted with teak in 1930, some *Dendrocalamus strictus* seed was sown in patches, which germinated satisfactorily. It appears that raising of an understorey of bamboos by broadcast sowing presents little difficulty. *Cleistanthus collinus* is another species very suitable for growing under pure teak forests and trials will be made next year.

### (x) *Silvicultural Systems.*

31. *Conversion systems*.—(a) *Teak*.—Experience shews that in the good quality teak forests, some form of conversion system is silviculturally inevitable, and that clearfelling with a view to obtain a normal series of age-gradations is the ideal method, provided that there is sufficient established teak reproduction to restock the area and a fairly complete demand. In the frost-labile forests on low lying areas, retention of part of the overwood either directly above the young crop or in strips as shelter belts, is considered essential. In forests which contain a dense understorey of bamboos, these are being cut a few years ahead of the main fellings to prevent suppression of young teak, as it is observed that bamboo regrowth is not very vigorous under cover. Bamboos are cut a second time along with the main crop, and if necessary, interfering culms are lopped in the year following the clearfelling. This prescription is proving very effective in the Bori and North Chanda forests.

(b) *Sal*.—Where regeneration of sal is very sparse, the conversion of such forests to even-aged stands resolves itself into

devising methods for inducing reproduction and getting it established. Little effort has so far been made to tend the existing advance growth or to induce regeneration where it is absent. *The sal forests of Baihar* (Balaghat) were worked under selection-cum-improvement fellings from 1900 until 1925, when they suffered for some years from a severe attack of the sal borer, which made it necessary to confine exploitation to attacked trees. The revised plan of 1932, prescribed for the first time conversion into even-aged stands by regeneration under a shelterwood, in a floating periodic block. The results in the first year's coupe were fairly satisfactory and to-day it contains a moderately well-stocked young crop about 20' high which has struggled through the bamboo regrowth. Another matter which deserves attention is the physical damage caused to the regeneration by the enormous quantity of slash left after exploitation, because small poles and fuel are not saleable, and the burn is never complete. More thorough burning, repeated in the second year if necessary, will go a long way in helping the regeneration.

In the frost-free forests of Raipur, conversion into even-aged stands under the uniform system with successive regeneration fellings, has been practised since 1924. The earliest coupes now contain a fairly uniform and well stocked pole crop 15' to 25' high and 1.5" to 2.5" diameter.

32. *Modified Coppice System*.—This system which has been applied to the mixed forests, and the inferior teak forests, in several divisions is not proving at all satisfactory. In the teak forests and in the dense stands of mixed forests of good quality, where the resulting vigorous coppice soon kills out the weeds and grass, the system has succeeded to a certain extent but not so in the openly stocked mixed forests, where the system degenerates into a wholesale clearfelling. Apart from resulting in a dense growth of tall grass the fire-hazard is also increased, and two or three fires in rapid succession can completely wipe out the forest. Similarly a frost can do very considerable damage in these incompletely stocked young forests. These dangers are reduced to a minimum by working these forests under the more conservative and elastic prescriptions of the *coppice with standards*, and more so, the *coppice with reserves* system which is tending to become the present policy.

#### (xi) *Miscellaneous.*

33. In P. B. I. in North Chanda, where the dense bamboo and teak advance growth are cut some years in advance of the main

fellings, a controlled light burn is proving efficacious as it destroys the bamboo slash and results in more vigorous teak coppice growth. Wherever late fires have occurred in Hoshangabad, teak coppice has been killed outright or severely damaged, but recovers very quickly. More damage has taken place in the comparatively open mixed forests which contain seas of grass.

34. *Seoni Experimental Plot No. 2 (1935)* was laid out to determine the earliest stage at which rigid fire protection can be replaced by controlled early burning as a safeguard against fires in regenerated teak forests with a rank growth of *Imperata arundinacea*.

Plots are early burnt after 3, 4, 5, etc., years after main fellings and the effect on all the regeneration recorded. The experiment was getting unwieldy and, at the suggestion of the Central Silviculturist, it was simplified and the initial comparability of all the sub-plots more definitely established. It is too early to draw any conclusions except that burning in the second and third year is too premature as it kills most of the regeneration. An important observation made in this experiment is that as a result of two burns *Imperata* grass has diminished very considerably and its place is taken up by the comparatively harmless *Anthistiria ciliata*.

35. *Frost*.—A cold wave passed over the province between the 25th of December 1936 and the 10th of January 1937; a mild frost occurred on the night of 26th/27th December and a severe one on the night of 6th/7th January.

Very serious damage, particularly in clearfelled regeneration areas at the foot of hillslopes and in valleys is reported from many divisions, notably Nimar, Betul, Hoshangabad and Balaghat. Fortunately, the more valuable bamboo bearing teak forests are situated on the higher slopes, which are immune. The strip and group fellings started in 1935 in the sal forests of Jubbulpore appear to have achieved their object as the young sal escaped damage in the coupes of the High Forest Felling Series, while in the Coppice Working Circle, where the felled strips were 90 feet wide against reserved strips of 30 feet, only partial damage occurred.

In the sal regeneration coupes in the Balaghat division, the coupe, clear-felled in 1932, where regeneration is now about 20 feet in height, escaped injury but the younger coupes were badly hit and will need to be cut back. The retention for five years of a

shelterwood of 30 large crowned trees per acre has now been prescribed.

### *Grazing.*

36. Heavy and continuous grazing in the Pohara reserve of the Amraoti division has resulted in an increase of *Acacia catechu* and *Acacia cásia*, both of which are thorny species and as such not touched by cattle. The proportion of inferior grasses such as *Eragrostis tenella* and *Andropogon contortus* is also increasing; whereas in an adjoining area, in which no grazing is allowed and grass is removed by cutting, the proportion of *Ischæmum sulcatum*, a good fodder grass, is increasing. In the C class forests which are permanently open to unrestricted grazing there is practically no regeneration and the quality and the quantity of fodder grass is steadily deteriorating. In several divisions the premature opening of regenerated teak forests to grazing, after a closure following the main fellings of 5 years or even less has been tried. This has not resulted in any appreciable damage by cattle to the young crop.

37. The grazing experiment in Yeotmal to determine the optimum incidence and periodicity of grazing and closures conducive to the gradual improvement of the wooded pastures is progressing very satisfactorily. The site selected is a forest on black cotton soil in the trap country. A similar experiment has now been laid out in Saugor on sand-stone to compare the variations due to the change in the soil and the underlying rock.

## II.—WORKING PLANS AND STATISTICS.

### (i) *Working Plans.*

#### Revision.

38. Revision of the working plans of North Chanda, Melghat and Raipur mixed forests was completed during the year and the plans were introduced with effect from 1st July 1936.

The following plans were under revision during the year:—

*Hoshangabad.*—The first ten yearly revision of the current plan of 1928 was considered necessary, to amend certain prescriptions in the light of experience gained in the last decade.

*Buldana.*—The revised plan will be based on a thorough stock-mapping of the forest and its main feature will be the systematic working of the *Hardwickia binata* forests which are a feature of the tract with which the plan deals.



## Amendments.

39. No important amendments were issued during the year.

(ii) *Statistical.*

40. *Sample plots.*—Owing to an unfortunate misunderstanding, the only teak sample plot in Betul was clear-felled. A new sample plot in C. P. IVb quality young teak forest was laid out in Nagpur-Wardha division. Thus the total number of plots, at the close of the year, remained unchanged, viz., 111. All of these were properly maintained.

41. *Tree increment plots.*—The existing 10 plots were maintained and no new plots were added during the year.

42. *Experimental plots.*—No new plots were laid out during the year.

43. *Management of bamboos.*—*Balaghat Experimental Plot No. 5 (1934).*—The all-India investigation with the object of determining the best method of working *Dendrocalamus strictus* for maximum sustained yield is in progress. 500 average-sized clumps are under observation in a practically virgin forest chiefly of *Pterocarpus marsupium*, *Dalbergia latifolia*, *Diospyrus melanoxylon* and *Bombax*, with an almost complete under-cover of bamboos. The clumps are divided into three sub-plots A, B and C which are to be worked on felling cycles of 3, 4 and 5 years respectively. Every year the production of new culms and the casualties of older culms are carefully recorded for each clump.

*In the Balaghat Experimental Plot No. 6 (1934)*, the object is to study the life of individual culms. Condition of all culms in 20 cleaned and 20 uncleaned clumps is recorded from year to year.

Both the experiments are progressing very satisfactorily.

44. *Preservation plots.*—An up-to-date list of all the preservation plots and the permanently reserved single trees and groups of trees has been prepared.

45. *Inspections.*—All inspections and measurements due during the year were carried out.

## III.—MISCELLANEOUS.

46. The office of the Silviculturist was held by Messrs. H. C. Watts (1st April to 14th September), H. C. B. Jollye (26th October to 3rd March) and K. P. Sagreiya (rest of the year), Deputy Conservators. They together toured for 186 days during the year. The Central Silviculturist toured in the province from 1st February to 3rd March.

47. A number of photographs and stereoscopic pairs of various subjects were added to the collection.

48. *Ledger filing* of important notes is kept up-to-date as far as possible with the insufficient staff.

## COORG.

### I.—EXPERIMENTAL SILVICULTURE.

1. *Teak seed pre-treatment experiment*.—Routine pre-treatment experiments were carried out as in the previous year, the treatment being weathering in shallow pits, scorching, soaking 48 hours and 24 hours with an untreated control. These have produced good results.

2. *Teak seed storage test*.—Three tests were carried out with the same sample of seeds in three consecutive years. Seeds stored in air tight tins were sown and beds covered with straw, watering occasionally once or twice a week. Second year test gave a higher percentage of germination. The untreated control has given the best results and next comes soaking 48 hours.

3. *Germination test*.—(a) *Teak* (nursery).—The untreated control has given the best results and soaking 48 hours comes next. (b) *Santalum album* (sandal). As in 1935, seeds without pulp have again given good results. (c) *Evergreen species*.—The following species were experimented with:—(a) *Acrocarpus fraxinifolius*, (b) *Artocarpus hirsuta*, (c) *Swietenia mahagoni*, (d) *Pterocarpus dalbergioides*, (e) *Xylia xylocarpa*, (f) *Dipterocarpus indicus* and (g) *Cedrela toona*. *Acrocarpus* gave very low and *Xylia xylocarpus* high germination.

4. *Aleurites fordii* and *Aleurites montana*.—Nurseries were opened at 5 different centres where germination commenced in 4 weeks' time. Germinating seeds were then pricked out and planted in baskets filled with good forest top soil and cow dung manure.

5. *Oil palm cultivation*.—Seeds were sown to a depth of one inch in nursery beds at Makut, spaced 6' x 6'. Germination commenced in 2 months, and about 83 per cent. germinated. The seedlings in the nursery are coming up well.

6. *Bambusa arundinacea*.—Seeds were sown in nursery beds at three centres with about 80 per cent. germination in all, of which 50 to 60 per cent. are now surviving.

### *Sandal Regeneration.*

7. Sandal was experimentally sown in open and under bushes with *dal* (*Cajanus indicus*) and *Cassia siamea* as hosts. Better results were obtained under bushes where the percentage of germination and survival was 68 against 55 in the open.

8. The method of regenerating sandal by propagation centres in different ranges was continued during the year. In Tittimatti and Nagerhole, dibbling gave 90 per cent. success, while in Somwarpet, transplanting produced better results with about 65 per cent.; in Fraserpet it was complete failure.

### *Artificial Regeneration.*

9. *Premonsoon teak stump planting*.—Two experiments were carried out in 1934 and 1935. The mean heights of plants put out on 1st May 1936 were after the first season, 12·96" and 13·8" with survival percentages of 96 and 97 respectively. The best date for stump planting in Coorg would thus appear to be between the 25th April and the 10th May.

10. *Effect of taungya (kumri) crop on the growth of teak in a plantation*.—The results of experiments, repeated in 1936, also indicated that in many cases the percentage of survival as well as height growth were higher in the control, except in the case of paddy where the height growth of teak was better than in the control. The plants, which were from direct sowings, had however a height of less than two inches on the average, so that the results are not conclusive.

11. *Best planting distance for teak and its effect on height growth*.—Two experimental plots were opened, where three espacements were introduced, *viz.*, 6' × 6', 4½' × 4½' and 3' × 3'. The seedlings in these plots were not burnt and cut back at the end of the 1st year, but at the end of the 2nd year two plots were burnt in the last week of March and seedlings cut back immediately after. Stocking was 85 per cent., but it is too early to give any other indications as the experiment is a long term one.

12. *Cover crops—Tephrosia candida (boga) introduced in a teak plantation*.—Some experimental areas, dibbled with teak and kumried in the first year of formation, *boga* was introduced in between teak (centrally in quin-cunx) in the 2nd year. In all centres the growth of *boga* was found to be good. Teak survival everywhere was better in the control than in *boga* strips, so also its height growth. This shewed that *boga* was harmful in the 1st and 2nd year of plantation as it suppressed the teak seedlings.

13. *To compare (a) weed cutting, (b) aeration by forking and (c) scraping with hoe.*—To determine the effect on the development of teak during the 2nd year of formation, measurements of seedlings have indicated that aeration by forking has given the best results both in survival and height growth.

14. *To compare teak (a) stumping and weeding, (b) stumping and scraping, (c) stumping and kumri (taungya) with ragi (Eleusine coracana), (d) sowing and weeding, (e) sowing and scraping and (f) sowing and kumri with ragi.*—An experimental plot was opened last year. Stumping has so far produced the best results both in survival and height growth. The growth of plants in scraped strips was found to be very good. The cover crop of ragi (*Eleusine coracana*) was found to retard the growth of young teak to a certain extent.

15. *Underplanting teak areas with Dalbergia latifolia.*—Observations in experimental areas of 1933-34 and 1935 were continued. About 80 per cent. of the plants exist but they are whippy and unhealthy.

16. *Effect of burning and cutting back a teak plantation in the 2nd year of formation.*—The experiment was repeated in a 1935 area that had been dibbled with teak and kumried in the first year of formation. The difference of growth between burning and cutting back is very little so far.

#### Miscellaneous.

17. *To study the growth of sandal in plantations with teak as hosts.*—The stocking of sandal was 60 per cent., plants being 8' to 12' in height; and the stocking of teak was 80 per cent., plants 12' high. Sandal is now being introduced round all young teak areas. Sandal sample trees have been selected in all working centres and girth measurements and conditions are being recorded for working plant purposes. Spiked sandal trees are treated with "Atlas", and as a result, the incidence of spike has considerably been reduced.

18. *Sandal spike incidence.*—In 1928 Hudgur plantation containing 12 acres of good sandal (about 25' high with an average girth of 12"), only 3 sandal trees were found spiked for the first time early in August 1936. The incidence has been carefully located, mapped and an ecological survey of all growth including shrubs, etc., up to a radius of 55' from the centre of infection has also been made. So far no other trees have been attacked.

19. *Sandal observation area of 1936.*—There has since been a considerable increase in the stocking of sandal except in one plot

where *Lantana* was uprooted, and stocking reduced by cattle damage. Results are being closely watched.

20. *Teak defoliation experimental areas in South Coorg.*—Defoliation was noticed in Tittimatti range in May in a severe form. In the eastern forests, however, it was not so severe.

21. *Experiment in the Closed Working Circle for eradication of grass.*—The object is to eradicate the dense growth of grass and to assist teak plants to develop. A small area was clear felled and burnt in early April 1936. It was then staked 5' x 5', and dibbled with teak seeds and divided into three equal plots. In one, bamboo cuttings were planted at an espacement of 10' x 10', in another, *Lantana* natural seedlings transplanted, 6' x 6', and in the 3rd, bamboo natural seedlings introduced at 10' x 10'. The stocking of teak is 80 per cent., the seedlings being 1' 6" in height.

*Lantana* has been established successfully and about 95 per cent. seedlings survive. Bamboo cuttings have been a complete failure.

22. *Regeneration in evergreen forests.*—Strip enumerations shewed that natural regeneration of important species, e.g., *Vateria indica*, *Hardwickia pinnata*, *Artocarpus hirsuta*, *Dipterocarpus indicus* and *Palaguium* was plentiful.

23. *Artificial regeneration work.*—So far *Hopca* transplants have yielded the best results. Next comes *Artocarpus hirsuta* and *Acrocarpus fraxinifolius*. In areas clear felled and kumried at Makut *Xylia xylocarpa* and cashew nut (*Anacardium occidentale*) have yielded the best results. As regards bamboo, sowing of seeds, cuttings and rhizomes were experimented with,—the first gave the best results.

24. *Hopca parviflora under shade.*—Out of 530 seedlings planted under shade 417 had survived. The percentage of success at the end of the year was 93, the plants are coming up well and some are about a foot in height.

25. *Frill girdling and poisoning with Sodium arsenite.*—In order to study the effect of girdling unwanted species as a substitute for improvement felling, a worked out coupe of 50 acres was selected and divided into 5 strips. In the first, all trees were girdled, and in the remaining 4 the trees were frill girdled and treated with sodium arsenite. The frill was about 2 inches deep and extended for about 12 inches down the bark of each tree. So far girdling seems to have had no effect. As regards poisoning, lower girth classes have been affected the most, the trees being dead in some cases while leaves are withering in others. Further results are being watched.

## MADRAS.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

In this brief report it is not possible to give full experimental data to support all statements made or opinions given nor does space permit mentioning all items of work undertaken. For fuller information the Annual Report on Silvicultural Research in the Madras Presidency for the year 1936-37 published separately should be consulted.

A large proportion of the work done has been small scale stage I (a) experiments in experimental gardens and routine seed germination and weight tests.

The most important results obtained during the year are probably:—

- (a) Further demonstration of the necessity for *rab* regeneration in dry fuel forests. Apart from the mortality caused by man, grazing, fires, etc., the ordinary coppice felling causes about 7 per cent. of the stools to die each time the operation is done and preliminary counts show that natural regeneration is very scarce indeed and of the order of 3 seedlings per acre.
- (b) Improvement in district *rab* work particularly in the successful raising of forest crops in conjunction with field crops in dry fuel forest areas (such as *ragi* and castor in Madura district and cotton in Salem Central division).
- (c) Demonstration of the great benefits of soil working in the 1st year of *rab* regeneration in dry fuel forests.
- (d) Collection by experiment of statistics of teak stump production in nurseries and the methods by which economies can be made. In conjunction with this is the demonstration of the fact that in years of shortage, undersized stock in the nursery can be developed into good stock for the following year. These results are particularly important in view of the very poor seed year that occurred last year and the resulting shortage of stumps that followed.
- (e) Summary of 5-years' experimental work at 3 centres in the premonsoon stump planting of teak.

- (f) Large scale confirmation by districts of experimental work in the premonsoon stump planting of teak and of the beneficial effect of using stumps of the best size.
- (g) The improvement of our knowledge of the regeneration and working of bamboos.
- (h) The continued success in the control of new outbreaks of the spike disease of sandal.
- (i) The summary by the Forest Entomologist, Dehra Dun, of the results of the investigation into the spike disease of sandal.
- (j) The further confirmation that *Lantana* can be controlled by chemical spraying and that this method is the cheapest method found so far.

#### *Climate.*

Rainfall statements are given in the full annual research report.

#### (ii) *Natural Regeneration.*

##### By Seed.

Experiments with *Hopea parviflora*, *Calophyllum elatum* and *Mesua ferrea* so far show that clearing undergrowth and raking the soil under mother trees are not beneficial in inducing natural regeneration. The indication is not conclusive as there have only been small seed falls since the experiments were started.

Canopy opening over young regeneration of *Hopea parviflora* was found to be very beneficial but produced no notable effect with *Mesua ferrea*.

Experiments have been started to endeavour to determine why at Nilambur some mature trees of *Sivietenia macrophylla* have a dense mass of natural regeneration under them while other trees produce none.

Partial canopy removal over dense regeneration of *Pterocarpus santalinus* produced a very beneficial effect in spite of a year which was very unfavourable climatically.

##### By Coppice.

Experiments in the dry fuel forests of Chittoor district showed that the ordinary operation of coppicing causes a mortality of

approximately 7 per cent. of the stools and that trimming of the stools is definitely harmful in such areas.

Counts of natural regeneration in coupes in North Coimbatore division 5 years after the coppice felling showed that seedlings to the extent of only 3 per acre were present.

An experiment in the coppicing of *Mimusops herandra* in the coastal forests of Tanjore showed that this species only coppices well in small sizes, that the mortality of stools increases rapidly with the girth of the stools and that even with the small sizes, mortality is high if the coppicing is done near to the ground level.

### (iii) Seed.

*Seed pretreatment.*—Routine pretreatment tests were done with 21 species. Treatment with boiling water improved the germinative capacity of *Acacia auriculiformis*, *Acacia cyanophylla* and *Acacia dealbata* but was harmful for nearly all other species tried. Soaking in cold water was beneficial with *Gluta travancorica*, *Pterocarpus santalinus* and *Xylia xylocarpa* being very marked in the case of the *Pterocarpus*. Concentrated Sulphuric Acid hastened and greatly improved the germination of *Cassia fistula* and *Cassia marginata* while fermenting greatly improved that of *Terminalia chebula*.

*Seasonal collection.*—Tests made with 10 species again showed no definite variations in germinative capacity throughout the fruiting season.

*Santalum album—peculiar variety.*—A sandal tree in North Salem division which is in a virulently spiked area and which has all the appearances of being spiked, fruited during the year. This tree has been under observation for 10 years and by grafting its tissue on healthy trees no disease can be induced. The seed was normal in germinative capacity and in weight and gave rise to seedlings some of which had healthy foliage and some spike like foliage. They are being kept under observation as they are possibly a variety of sandal immune to the disease.

*Seed storage.*—Routine tests were made with 24 species to determine the longevity of the seeds stored in different ways. Results are given in the full Annual Report.

*Seed weighments.*—Routine tests were carried out as usual. Results are given in the Annual Report.

*Sorting seed by size.*—Work done during the year confirmed previous years results that the sorting of teak seed by size is not justified economically.



Tests with seeds from small immature, normal mature, and large over mature seed bearers with 4 species showed no appreciable differences in germinative capacity or height growth of the resulting seedlings. Large scale Experimental Plots have been established to test the effects in later growth.

*Seed origin.*—Small scale experiments with teak seed of 6 origins have all showed comparatively little difference between the origins in early growth. We have 2 large scale long term Experimental Plots in this subject each now 3 years old. Sample plots will be laid out in each origin when the 1st thinnings become due.

#### (iv) Nursery Work.

In hot dry fuel areas shaded nursery beds gave generally a higher germinative capacity with nearly all the 20 species experimented with but in subsequent development and survival individual species exhibited different light requirements.

In evergreen nurseries, protection by sheltering from the very heavy rain of the south west monsoon resulted in a much higher percentage of survivals with *Artocarpus hirsuta*. In the hot weather, *Hopea parviflora* seedlings benefited by shade in the nursery while *Cedrela toona* seedlings did much better in the open.

An experiment on nursery watering in a dry fuel area showed that with these species watering should be very light until germination is over and should then be increased to give increased height growth and survivals.

Work on different nursery methods for raising teak stumps confirmed previous years results that the best outturn of good stumps is obtained by sowing seed at the rate of 20 to 30 lbs. per standard 40' x 4' bed and doing no pricking out of seedlings at all. A bed of this size in this way will produce after 1 year sufficient stumps of the right size to establish fully 1 acre of plantation at a 6' x 6' espacement and still leave a margin of safety.

Further experiments also showed that if owing to a poor seed year and consequent shortage of stumps, the undersized stumps have to be used, they are best put back into the nursery beds as stumps for a second year. At the end of the second year some 70 per cent. of them will have grown to the right size and they can then be stumped again and planted out. Results show that these stumps sprout as well as fresh stumps but their subsequent growth has yet to be determined.

Experiments to determine whether teak nursery beds deteriorate if they are used repeatedly and whether their fertility can be maintained by artificial or green manures have been started. Results so far show no deterioration in the 2nd year and an increase of 5 per cent. in the utilizable stumps produced in the beds manured with wood ash and leaf mould.

#### (v) *Artificial Regeneration.*

##### (a) *Mixed deciduous timber forests.*

*Comparison of sowing, transplanting and stumping.*—Previous years results were confirmed and showed that for *teak*, *Dalbergia latifolia*, *Pterocarpus marsupium*, *Terminalia crenulata* and *Artocarpus hirsuta* stump planting is the best of the 3 methods while for *Xylia xylocarpa* direct sowing is to be preferred. *Pterocarpus dalbergioides* and *Swietenia macrophylla* do best by transplanting.

*Optimum season for stump planting.*—Experiments were repeated for 5 species and in general confirmed previous years results. Last year was the 3rd consecutive bad year for early rains, the hot weather was unusually hot and in many places premonsoon showers were absent. The south west monsoon however broke about a fortnight earlier than usual. The result of this was that the best date of planting moved forward to April 1st but in many places the new sprouts could not last through the 2 months drought that followed and the most successful date of planting in consequence varied from April 1st to May 15th according to species and conditions.

Five years work in this subject has now been completed for teak in 3 centres and the results are summarised in the full Annual Report.

District work in 25 areas in 7 districts aggregating some 750 acres substantially confirmed the results of small scale experiments.

*Stump planting—Effect of age and diameter of stumps.*—Teak stumps of 0.4" to 0.8" diameter at the thickest part gave the best results though stumps of 0.3" to 0.4" diameter are definitely "usable" in the event of shortage of the larger stumps though they do not give as good results. The benefit of using stumps of the best size was demonstrated and confirmed by district work in the Wynad division.

Work with *Dalbergia latifolia* again showed that 2-year old stumps are better than 1 year old stumps and 0.2" to 0.6" diameter

is the best range of size. For *Pterocarpus marsupium* results indicate that the larger stumps of 0.3" to 0.8" diameter (or even larger) give the best results. Results for *Terminalia crenulata* show 0.4" to 0.8" diameter to be the best size, and for *Artocarpus hirsuta* within the range experimented with, the bigger and older the stumps the better the results.

Experiments in burying teak stumps when planting them compared with normal planting showed no differences for normal 1st June planting but buried stumps were definitely better in the case of premonsoon (April 1st) planting.

*Storage of stumps—teak.*—Experiments again showed that stumps can be successfully stored for 2 weeks before planting even in an abnormally poor year climatically.

*Irrigated plantations—teak.*—Preliminary experiments in this subject show that irrigation by flooding (as in paddy cultivation) is more difficult and more expensive to do than irrigation by percolation from channels and gives no better results. Flooding also uses much more water.

Experiments have been started with *Swietenia macrophylla* to determine the best espacement and the best shade condition in which to grow the species. The season and incidence of its 2 great pests, the shoot borer and the collar borer are also being determined under these various conditions.

A number of experiments were done to determine the best method by which to regenerate *Bambusa arundinacea* and *Dendrocalamus strictus*. Further work is needed before definite results can be confirmed.

*Casualty replacements in 2nd year teak plantations.*—Observations of current experiments in this subject were continued. Results indicate that few of these replacements survive and it is doubtful if they ever take their place in the main crop.

*Effect of taungya (ponam) crops on teak plantations.*—Previous work was repeated and shows that *ragi* (*Eleusine coracana*) retards the height growth of the teak by 40 per cent. in the first year while *dhall* (*Cajanus indicus*) has very little effect. This retarding effect of the *taungya* crop can be greatly reduced by early planting the teak.

#### (b) Evergreen rain forests.

All artificial regeneration work in evergreen forests (with the exception of experiments on raising evergreens after clear felling

and burning) comes under the category of underplanting and is therefore dealt with under that head.

### (c) Dry fuel forests.

Artificial regeneration of dry fuel forests by the *rab* method is being done on a larger scale each year in almost all divisions where this type of forest occurs and results are getting more and more encouraging as the technique improves.

The greatest advance of the last few years is in the raising of these dry fuel species in conjunction with field crops such as *ragi* (*Eleusine coracana*), castor (*Ricinus communis*) and cotton (*Gossypium barbadense*). A detailed description of this work is given in the full Annual Report.

Results of experimental and district *rab* work show that regeneration is best raised by direct sowing with most species. The best date of sowing varies greatly each year and the most practical method found is to sow early and to go on resowing at reasonable intervals until full stocking is obtained. (Seed is generally plentiful and cheap.) Transplanting and stump planting are in general not suitable to these species in this type of area.

The following species have given excellent results:—*Cassia siamea*; *Albizzia lebbek*, *Azadirachta indica*, *Dolichandrone crispera*, *Acacia sundra*, *Albizzia odoratissima*, *Pterocarpus santalinus*, *Albizzia amara*, *Wrightia tinctoria*, *Zizyphus jujuba*, *Pithecolobium dulce*, *Acacia ferruginea*, *Prosopis juliflora*, *Tamarindus indica*, *Acacia planifrons*, *Acacia arabica*, *Pongamia glabra* and *Cleistanthus collinus*.

A good burn coupled with soil preparation before sowing is essential for this work.

Soil working during the 1st year is very beneficial. It not only produces a much increased height growth but also enables backward plants to survive the hot weather.

A successful start has been made in the raising of plantation to be worked for manure leaves by the planting of large shoot cuttings of *Poinciana elata*.

Stump planting of *Santalum album* has given a large measure of success and it has also been demonstrated that sandal stumps can be kept in air-tight tins without deterioration for 3 weeks before planting.

Detailed experiments were also done on the influence of host plants on the seeding of sandal, and the extent of and the necessity

for parasitism of this species. It is to be noted that results show that even though growing in close proximity to many species sandal usually only parasitises freely on a few particular species.

(vi) *Afforestation.*

Experiments to examine the possibility of re-afforesting some of the more important catchment areas of the Nilgiris were continued and so far have given the following general indications:—

- (a) The moister localities can be easily stocked with willows by cuttings. They are frost hardy but need protection from browsing.
- (b) Small, close planted, concentrated plots do better than large areas of open planting owing to more efficient frost protection being possible.
- (c) Frost protection is best done by means of a complete pandal about 1' 6" from the ground and screened on the up hill side.
- (d) Nurse species can be raised as follows:—
  - (i) Broom, *Dodonea viscosa*, *Cassia tomentosa* by sowings.
  - (ii) *Buddleia* spp. by cuttings.
  - (iii) *Ligustrum neilgherrense*, *Rubus moluccanus*, *Rubus lasiocarpus*, *Myrsine wightii* and *Hypericum mysorensense* by planting stumps got from the forest.
- (e) Tree species can be raised as follows:—
  - (i) *Acacia dealbata* by 2 years old large transplants.
  - (ii) *Cupressus macrocarpa* and *Callitris rhomboidea* by small transplants and these can come from the forest if necessary.
  - (iii) *Acacia melanoxylon* and *Eugenia arnottiana* by mossed transplants.
  - (iv) *Mahonia leschenaultii* by stumps and these can come from the forest.

(vii) *Tending, Thinning, Cleaning, etc.*

*Weeding practice.*—Large scale experiments were done in continuation of the work of the past few years and results again conclusively confirm previous years' results that the slightly beneficial effect (if any) of forking as opposed to mamooty scraping as a weeding method in the first 2 years of a teak plantation in our better teak areas is in no way commensurate with the extra cost

of forking. The saving by mamootty weeding instead of forking is approximately Rs. 3 to Rs. 5 per acre each time the operation is done and when this is totalled for the main teak districts of the Presidency it is an annual saving of a considerable sum of money.

These experiments were all done in areas with a naturally light friable soil and a rainfall of 60" to 120" per annum. The effect of forking in dry fuel forests has already been noted on page 67.

*Effect of a cover crop of Leucaena glauca on a teak plantation.*—In an experiment in this subject the teak with the cover crop showed an increased height growth over that of the control teak at the end of the 1st year but this increase had greatly diminished by the end of the 2nd year. The *Leucaena* was continually browsed by deer and bison and was no use at all as a weed suppressor.

*Thinning research—teak.*—All plots in this subject were maintained but there is nothing of particular interest to report.

*Bamboos.*—Experiments on the intensive tending and working of bamboos were continued and showed that such intensive work is economically justified by the improvement in the condition and yield of the clumps and the increased revenue obtained.

#### (viii) *Mixtures.*

Nil.

#### (ix) *Underplanting.*

(a) *Teak plantations.*—All plots were maintained but no new work was undertaken. Experience so far indicates that teak plantations can be successfully underplanted with *Bambusa arundinacea*, *Cephalostachyum pergracile* and *Hopea parviflora*. *Swietenia macrophylla* and *Cedrela toona* although established suffer a great deal from browsing and bark stripping by deer.

(b) *Evergreen rain forests.*—Experiments in the regeneration of evergreens with and without a cover crop after clear felling and burning evergreen forest have been started and show promise. Most of the work of the past few years has been in underplanting under various degrees of canopy. General results are:—

- (i) Top canopy cover gives the best results.
- (ii) Burning before regeneration produces no beneficial results.
- (iii) For most species transplanting is the best method and some of the tenderer species do well if mossed or basketed.

- (iv) Stump planting is not a suitable method for most evergreens. The exceptions to this are *Artocarpus hirsuta*, *Cedrela toona* and *Chickrassia tabularis*.
- (v) Weeding is worth while as it gives a slight gain in height growth and survival percentage.
- (vi) Pitting for planting is also similarly worth while although the effects of pitting do not show until the second year when the roots and their needs have both got bigger.
- (vii) The best date of transplanting for most species is mid June or early August, i.e., either just before or just after the heaviest rain of the south west monsoon.
- (viii) For most species the best size of transplant to use is from 8" to 1' high. Larger transplants occasionally do well but suffer heavy casualties and are not definitely established for several years. In the case of large transplants of *Cedrela toona* and *Swietenia macrophylla* insect attack is more serious than with small plants.

(x) *Silvicultural Systems.*

Nil.

(xi) *Miscellaneous.*

*Sandal Spike Disease Research.*—Details of work carried out during the year cannot be given in such a brief report as this. The Forest Entomologist, Dehra Dun, inspected the work during the year and summarized results so far obtained as follows:—

- (i) Spike is an insect borne disease.
- (ii) The disease is excluded from a plant by barriers of cloth and of wire gauze of 20 meshes to the inch; it is not excluded by wire netting of 2 meshes to the inch.
- (iii) Small wind borne insects penetrate 20 mesh wire gauze and hence are unlikely to be vectors.
- (iv) The vector passes an aperture of half an inch, hence many large bodied and long legged species are unlikely to be vectors.
- (v) The vector frequents sandal foliage during the period dusk to dawn.
- (vi) The vector is probably either (A) an uncommon species or (B) an uncommon strain of a common species.
- (vii) The vector is active as a transmitting agent at two seasons of the year, February to May and July to December

but population surveys show that the incidence of sandal sap-suckers falls very low in June.

- (viii) Artificial transmission experiments have failed to produce spike but suspicious conditions have been produced by *Moonia* and by *Lantana aphids*.
- (ix) The common factors in these experiments were either (a) confinement with spiked plants and immediately after with healthy plants, or (b) confinement with spiked plants and immediately after with spiked and healthy plants and a long period of exposure. There was considerable variation in the nature and size of cage and in pruning or other after treatment.
- (x) Spike has been produced in 2 cases in large cages by releasing wild insects directly after collection.
- (xi) An exposure of one month is sufficient to permit infection.

Anti-spike operations carried out indicate that such control measures are fully effective in the case of areas where only a few trees are found infected and that in the case of large blocks of forest where the disease has been allowed to spread for some years uncontrolled, the effect of the control operations is to confine the disease to the original limits of the outbreak.

*Periodicity of height growth.*—Weekly measurements showed that in deciduous forest the general rest period was from the middle of November to the middle of April. In evergreen forest and in dry fuel forest most species grow slowly but steadily all through the year.

*Woods—Lantana eradication.*—Experiments in the suppression of *Lantana* by underplanting it with *Bambusa arundinacea* were extended and continue to look promising.

Large scale experiments in destroying this pest by spraying with a sodium chlorate spray show that the method is the most successful and least expensive of any method so far tried.

*Climber poisoning.*—Experiments were continued and show that most of the common species of climbers can be successfully eradicated at a reasonable cost by means of an arsenical poison.

Experiments on the suppression of *Eupatorium* by means of *kikuyu* grass (*Pennisetum clandestinum*) were extended and continue to look promising. This work is most important in the reclamation of grazing areas which have been invaded by the pest.



## II.—WORKING PLANS AND STATISTICS.

### (i) *Working Plans.*

Five working plans were under preparation at the beginning of the year and 3 were completed during the year. 3 new plans were started during the year.

The cost of preparation, inclusive of establishment, was Re. 0-6-6 per acre.

### (ii) *Yield, volume and form factor tables.*

During the year 10 sample plots were handed over to the new Orissa Province and 68 sample plots, 21 tree increment plots and 18 preservation plots were maintained.

## III.—MISCELLANEOUS.

### (i) *Tours.*

In accordance with item 1 (a)-(c) of Resolution No. 3 of the Dehra Dun Silvicultural Conference held in 1934 and under the sanction of the Government of Madras, the Provincial Silviculturist toured in East Bengal in November/December 1936 to study the regeneration of mahogany and evergreens. This tour was very instructive and of the greatest use.

The sandal spike research works in North Salem division were inspected by the Forest Entomologist, Dehra Dun, during the year who kindly summarised the work done so far and made valuable suggestions for future work.

The Provincial Silviculturist toured for 201 days during the year.

### (ii) *Records.*

The Specific and General Ledger Files now number 429 and 152 respectively.

Seventeen new Experimental Plots and 254 new Experimental Garden experiments were opened during the year while 13 Experimental Plots and 112 Experimental Garden experiments were summarised and closed during the year. At the end of the year 76 Experimental Plots and 287 Experimental Garden experiments were open.

Twentythree photographs were added to the collection during the year.

*Staff.*

The Extra Assistant Conservator of Forests remained in the division throughout the year as assistant. The subordinate staff now consists of 3 Research Rangers, 9 Foresters, and 1 Forest Guard.

During the year all arrears of office work and of the experimental records of the field work were cleared off and the office was up to date at the close of the year.

## NORTH-WEST FRONTIER PROVINCE.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

The main silvicultural problem continues to be the natural regeneration of blue pine (*Pinus excelsa*) in forests worked under the uniform system, particularly in the Galis division, where two long periods of drought, *i.e.*, from the beginning of May till the breaking of the monsoon in July, and again from the end of September till about Christmas, make it extremely difficult for the seedlings which germinate early in the monsoon to establish themselves.

(ii) *Natural Regeneration.*

The sample plots laid down to ascertain the most suitable intensity for a seeding felling in blue pine forests have given no definite results, but as mentioned above the main problem is not to get the seedlings on the ground, but to carry them on over the first few years of their existence.

Young growth already on the ground appears to belong to definite years with wide gaps in between and an investigation has been started to correlate the age of these seedlings with the rainfall statistics of the period following germination.

More investigation is necessary into the cause of death and arrangements are being made with the Punjab Research Division to lay down observation plots for both blue pine and silver fir, on both limestone and shale.

(iii) *Seed.*

The year 1936 was a very bad seed year for deodar, but a good one for blue pine and chir. 19 mds. 20 srs. of chir seed were sent to the Forest Botanist for supply to the South African Forest Department.

What had become almost a tradition, that Kagan deodar was of poor quality and that for artificial work in other places it was necessary to obtain seed from Kashmir, has now been definitely disproved, as large quantities of Kagan seed used in December 1935 to undersow a blue pine regeneration area in Panjul 7 (i) have given remarkably good results. Germination was profuse and by the end of the season the average height of the seedlings was 10 inches and some were 15 inches high.

#### (iv) *Nursery Work.*

In addition to the ordinary nurseries, maintained in the hill divisions, for re-stocking the areas felled over, a large nursery is maintained at Nowshera, and others at Cherat, Parachinar, and Malakand in the Peshawar division, for the supply of plants required for station planting and the re-planting of canal banks. A large nursery is also maintained at Razmak for the supply of fruit and garden plants, and despite the unsettled conditions of Waziristan, no less than 10,000 plants were distributed during the year.

#### (v) *Artificial Regeneration.*

*Cedrus deodara*.—Patch sowings of deodar continue to give the best results, particularly on patches where debris has been burnt. Planting is less successful, but in many cases this is due either to the use of undeveloped plants, or to planting at too high an elevation. Although doubts have been expressed regarding the advisability of continuing to introduce deodar into the Gali forests, there is no reason why it should not succeed provided work is confined to suitable elevations, not higher than 7,000 feet.

In Upper Siran it was found that sowings of deodar, made in April and May, immediately after the snow had melted, gave just as good results as sowings made in November and December.

*Pinus longifolia*.—During the last four years, chir plants raised in tin tubes have been successfully planted in the Cherat Cantonment and Malakand Agency forests, showing that this method can be usefully employed, where the locality factors are particularly difficult.

*Pinus gerardiana*.—This species has been successfully raised in the nursery at Narang in Upper Kagan, but sowings made in the forests have failed.

*Nannorhops ritchieana*.—Experiments made with the dwarf palm, a plant of great economic importance in the Kohat district,

have shown that, where irrigation is not available, it is almost impossible to grow this species either by planting of offsets or by sowing. With irrigation, however, it can be easily raised by sowing on the berms of trenches.

*Acacia modesta* and *Dodonaea viscosa*.—Experiments on the propagation of these two species, both in Cherat Cantonment and the Khawara reserved forest have shown that the best method is to sow in interrupted horizontal trenches. Germination is profuse immediately after the break of the monsoon, but the seedlings die off if there is more than ten days break in the monsoon. Some of the seed usually does not germinate until the winter rains, but in that case the seedlings never survive the hot weather.

*Exotics*.—Experiments are being continued to discover suitable exotics for introduction into the low hills of the Frontier. During the past four years some 4,000 plants of *Ailanthus glandulosa*, *Grevillea robusta*, *Maclura aurantiaca* (the Osage Orange), *Schinus molle*, *Eucalyptus rostrata* and *Robinia pseud-acacia*, raised in pots and tin tubes have been successfully planted and established with the aid of watering in the Cherat Cantonment, at an elevation of 4,000 feet, where both the soil and climatic conditions are extremely unfavourable. *Ailanthus glandulosa* has also been successfully introduced at elevations up to nearly 8,000 feet in the Galis division. *Pinus pinca*, *Pinus halpcnensis*, and *Pinus caribea* have also been raised in tin tubes in nurseries, but have not yet been planted out. At Parachinar experiments to discover a species of eucalyptus which will survive the winter show that *Eucalyptus globulus* is by far the best species.

#### (xi) Miscellaneous.

*Grazing*.—Further experiments were carried out in the Kagan division to study the effects of closure on both chir (*Pinus longifolia*) and blue pine (*Pinus excelsa*) regeneration.

In the case of chir, a grazing incidence of 6 acres per head of cattle has been found useful, as it keeps down the growth of grass, to the benefit of the seedlings.

With blue pine it has been found that grazing in regeneration areas is dangerous during the summer months (May and June), but once the monsoon has broken an incidence of 10 acres per head is beneficial.

Even in blue pine forests burdened with grazing rights, with an incidence of about 8-10 acres per head, it has been found possible to introduce deodar by sowing. Although the cattle

appear to prefer deodar to blue pine seedlings and damage is caused by trampling, sufficient deodar seedlings generally survive to form a mixture with the pine.

*Eradication of raspberry canes.*—Up-rooting and burning appears to be the only effective method of getting rid of this weed, which gives considerable trouble in some of the blue pine regeneration areas. The cost of this operation is, however, high, about Rs. 25 per acre.

## II.—WORKING PLANS AND STATISTICS.

### (i) *Working plans.*

The revision of the Galis working plan was commenced and it has been decided that the uniform system of management should be abandoned and a return made to the selection system. The yield will be calculated from a complete enumeration of all conifers 12" in diameter and over, standing in the area allotted to the selection working circle.

### (ii) *Yield, volume and form factor tables.*

The chir and blue pine sample plots, originally laid down by the Forest Research Institute, were maintained by the Punjab Silvicultural Research division, to whom they have been transferred.

Statistical data for standard and commercial volumes from one deodar and nine blue pine trees in the Kagan forests were sent to the Punjab Silvicultural Research division.

## ORISSA.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) *General.*

With the formation of the new Orissa Circle Mr. J. W. Nicholson, I.F.S., originally appointed as Research and Working Plans Officer had also to officiate as Conservator of Forests, and carried out the duties of both posts. Pressure of administrative duties, and the lack of an organised research staff, necessitated the postponement of the compilation of a programme of silvicultural research for the new Province. During the year it was possible to do little new work, but all work in connection with sample and experimental plots was brought up to date.

As only one officer will be available in future for both research and working plans work, Orissa will have to restrict silvicultural research work to really important problems, and the following statement shows the numbers of Experimental Plots existing in each division:—

| Division.       | No. of plots existing on 1st April 1936. | Abandoned during the year. | New plots laid out during the year. | Total No. at the close of the year. |
|-----------------|--|----------------------------|-------------------------------------|-------------------------------------|
| Angul . . .     | 25                                       | 13                         | 1                                   | 13                                  |
| Puri . . . .    | 25                                       | 10                         | —                                   | 15                                  |
| Sambalpur . . . | 6  | 5                          | —                                   | 1                                   |
| Barapahar . . . | 2  | —                          | —                                   | 2                                   |
| Ganjam . . . .  | 35                                       | —                          | —                                   | 35                                  |

### (ii) *Natural Regeneration.*

*Sal.*—The most important problem to be solved is re-obtaining sal regeneration in the *mals* forest of Puri division where fire protection has induced an evergreen invasion. The first experimental plots in this area were laid out in 1924. Since then other plots with new and improved technique have been added. No plots have as yet given definite results. The treatment of the oldest plots has been altered from time to time. Progress in the establishment of sal regeneration has been very slow, due largely to the fact that most of the mature seed bearers were felled when regeneration felling took place in P. B. I. The indications are that annual burning over a period of many years helps to induce invasion of grasses and reduction of evergreen species. It is not possible to burn the plots in a wet year, and as stoppage of burning operations, even for one year, helps evergreen growth to recover its vigour, the few plots, where biennial burning was prescribed, are not of much value. Other plots prescribed hoeing,—an operation which could not be carried out on a field scale. It was felt that the only practicable lines of attack were annual burning, annual shrub cutting, or a combination of burning and shrub cutting. As good burning is not practicable in the case of small plots, the whole forest in which the plots are situated will, in future, be burnt, except control plots due to be fire-protected.

Consequent upon the indications given by the sal regeneration plots a change was made in the burning prescriptions of the sal selection working circle. Hitherto, the area has been mainly under fire protection and the aim has been to concentrate cleanings on existing sal saplings. Owing to the evergreen growth, repeated

and expensive cleanings are required, and in the end a very incomplete sal pole crop will result. It was decided that a sounder policy would be to carry out a systematic programme of burning over a period of several years with the object of killing out most evergreen growth, and inducing conditions favourable to the establishment of sal regeneration. Once those conditions are obtained the area can be temporarily fire-protected, and cleanings carried out. In future, therefore, both in the old P. B. I. area and in the selection felling coupes, burning will be the usual procedure.

Four plots, laid out in 1925 and 1926 (now closed down) in Sambalpur division, to test the effect of burning after felling on coppice regeneration did not shew any significant difference in growth.

Certain plots, established in 1924 and 1925 in Angul division, to test the effect of burning on the establishment of sal regeneration in dry to damp types of sal forest have shown that establishment of natural regeneration has been adversely affected by late fires in the dry type where early burning will be done from now onwards.

*Casuarina*.—The experiments in layering casuarina tree branches have not yet given definite results.

*Teak*.—There are no teak plantations older than 50 years in the Circle, and hitherto the question of obtaining natural regeneration has not received attention. A bad cyclone in Puri division in October 1936 caused havoc in certain old plantations. It is now considered advisable to take steps to induce teak regeneration in middle aged crops. Divisional experiments carried out in the Puri *mals* indicate that by opening out 50 per cent. of the canopy, removing the undergrowth, and burning the debris, natural regeneration of teak is assisted.

### (iii) *Seed*.

Nothing of importance to record.

### (iv) *Nursery Work*.

The *dona* system of raising nursery seedlings (as a provision against shortage of stumps) was tried in Angul and Sambalpur divisions with yet indefinite results. Experiments are also in progress to ascertain the best technique for raising teak stumps of the optimum size within one year.

### (v) *Artificial regeneration*.

*Rab* sowings on Madras lines were tried in Ganjam and Barapahar divisions with teak, babul (*Acacia arabica*) and *Cassia*

*siamea* in coppice coupes of a dry evergreen thorn forest type of the former (Ganjam) and with *Terminalia arjuna*, *Terminalia tomentosa*, *Gmelina arborea*, *Dalbergia latifolia*, and *Pterocarpus marsupium* in a blank area on dry poor soil in the latter (Barapahur). The results obtained so far indicate that rab sowings offer a promising solution to the problem of stocking small blanks or introducing more valuable species in these and other divisions.

Planting of *Aleurites fordii* was tried in Puri division with poor results.

#### (vi) Reclamation and afforestation.

The re-afforestation of dry poor soils presents a difficult problem, and all previous attempts to introduce important tree species had failed,—including cuttings of even uneconomic tree species such as *Banyan*, *Boswellia serrata*. Cuttings of the shrubs like *Dodonea viscosa*, *Vitex negundo*, and *Isora parviflora* have, however, given fair results.

Of the various broad leaved species introduced in the Puri *Casuarina* plantation in past years, only *poonang* (*Calophyllum inophyllum*) and the *cashew* nut have succeeded,—the former only under shade. In 1936 the rain tree (*Enterolobium saman*) was tried and the survival percentage up to date is 92. Natural regeneration of *Odina wodier* and *Melaleuca leucadendron* is taking place in the plantation.

Anti-erosion experiments were initiated in Ganjam division in plains sal forests.

#### (vii) Mixtures.

Nil.

#### (viii) Tending.

As a result of a series of field experiments, the revised thinning rules for mixed coppice coupes which were published in the *Indian Forester* aim at increasing the proportion of valuable species and at thinning out the latter where necessary. No thinnings are done amongst inferior species, except where necessary to give room to principal species.

In the clear felled sal coupes of Ganjam division creeper cutting is done in one year old coupes, where the commonest pestilential creeper is *Mucuna pruriens*. The cutting and removal of these creepers causes damage to the leading shoots of sal.



Experiments have just been initiated to test if, instead of cutting these annuals (*Mucuna*), uprooting the perennial creepers at the beginning of the second rains would let the sal crop grow just as well.

Experiments started in Puri division in 1924 to test the effect of pollarding, pruning, and coppicing *kuchila* (*Strychnos nux-vomica*) trees on their fruit production were concluded with the result that no such artificial methods of stimulating fruit production have proved successful,—the untouched control plot having given the best results.

#### (ix) *Underplanting.*

Underplanting of teak stumps in a forest containing *Bambusa arundinacea* clumps was tried in Angul with poor results,—the shade being too dense.

#### (x) *Silvicultural Systems.*

The Palamau system of carrying out coppice fellings was introduced experimentally in some felling series in Sambalpur division, and it was also decided to try it in Ganjam division. Under this system clear felling is not enforced. Only marketable trees are removed by the contractor. All unmarketable promising saplings or poles of principal species are left to form part of the future crop; unpromising stems of principal species are cut back; and miscellaneous species interfering with the growth of principal species are cut back or girdled. The system should succeed well whenever market conditions do not admit of complete conversion. It avoids waste of promising saplings and poles; saves expenditure on unnecessary coppicing; reduces exposure of the soil; and by reducing grass growth minimises risks from fire.

The older set of experimental plots on *Dendrocalamus strictus*, laid out in Sambalpur in 1924, were initiated through faulty technique or maintenance and, therefore, closed down as inconclusive. These, however, have given some indications, *viz.*, (i) where fellings were done on a 3-year rotation leaving new shoots along with 7 old shoots, the yield of culms was just as great as in the control where no fellings were done; and (ii) under a clear felling system, 7 years is an insufficient felling cycle to produce culms of the original size.

A series of 5 plots established in 1929 to determine the best methods of cutting *Bambusa arundinacea* were also closed down as results have been vitiated by faulty maintenance of records. Interim results indicated that (i) felling of half the clump on a

3-year rotation proved too drastic for the clear felled halves to yield any new culms and (ii) under a clear-felling system of working, a rotation of 10 years was required to produce full sized culm.

(xi) *Miscellaneous.*

*Dying of Casuarina.*—For the last 3 or 4 years there has been considerable speculation over the causes of dying back of *Casuarina* trees over extensive areas in the Puri plantation. Originally it was imputed to water logging. Later, a theory was advanced that the water level had fallen owing to the construction of a drainage canal. Those which had died had never developed taproots but had a horizontal spreading root system. Just after the drainage canal was made, small vertical roots were sent down from the horizontal root system. The living trees within the area affected are all on higher ground and they possess one or more main taproots. It seems clear that in the failed areas the water level was originally very close to the surface, but on the water level falling, the later vertical roots sent down were unable to supply sufficient water to the tree system.

*Contour trenching.*—Contour trenching experiments initiated in 1935 in Angul division have given no results of value.

## II.—WORKING PLANS AND STATISTICS.

### (i) *Working Plans.*

A working plan for the private forests of Dalijora estate, which have been taken under Government management, was prepared, but was not finally approved of.

Certain amendments to the Ganjam, Puri, Sambalpur and Barapahar working plans were made. Planting of teak and *Gmelina arborea* was laid down in the plan for the Ravine Working Circle. In Sambalpur and Barapahar plans burning prescriptions were altered to admit of early burning operations being more extensively carried out. Changes were also made in marking rules and cleaning prescriptions, and the rules for marking standards radically altered. The so-called menace of bamboos to regeneration of tree species had been grossly magnified. In the early years after coppicing bamboos do appear to suppress tree species, but the latter usually push their way through in the long run, and then it is the bamboos that tend to become suppressed. It was decided that the best way of dealing with the bamboo menace was to restrict cutting of young culms to coppice coupes due to be worked

1 to 3 years hence. This should result in bamboo clumps having diminished in vigour at the time of coppicing.

(ii) *Yield, Volume, and Form Factor Tables.*

The number of existing Sample Plots is as follows:—

| Division.       | No. of plots existing on 1st April 1930. | Abandoned during the year. | New plots laid out during the year. | Total No. at the close of the year. |
|-----------------|--|----------------------------|-------------------------------------|-------------------------------------|
| Angul . . .     | 13                                       | —                          | —                                   | 13                                  |
| Puri . . .      | 60                                       | 5                          | —                                   | 55                                  |
| Sambalpur . . . | 20                                       | —                          | —                                   | 20                                  |
| Barapahar . . . | 11                                       | —                          | —                                   | 11                                  |
| Ganjam . . .    | 10                                       | —                          | —                                   | 10                                  |
|                 | —  | —                          | —                                   | —                                   |
| Total .         | 114                                      | 5                          | —                                   | 109                                 |
|                 | —  | —                          | —                                   | —                                   |

The 5 plots abandoned in Puri division represent teak plots in which nearly all standing trees were blown down by a cyclone in October 1936.

During the year interim measurements were carried out in 7 and full measurements in 18 plots.

Volume data for 100 trees of *Terminalia tomentosa* were collected in Angul division.

## PUNJAB.

### I.—EXPERIMENTAL SILVICULTURE.

#### (i) *General.*

(a) *Propagation of Prosopis juliflora.*—Pods were collected from known parent trees of different forms in Lahore and of Mexican form in Delhi. The total collection was 23 maunds. Of this  $9\frac{1}{2}$  maunds pods were from trees of Mexican form, about 10 maunds of Australian and the balance of other forms. About  $18\frac{1}{2}$  maunds of pods were issued to divisions and other Government departments;  $8\frac{1}{2}$  maunds of this were of Mexican form.

12,000 pot plants (11,000 of Mexican and 1,000 of Peruvian form) were raised at Lahore for distribution. Planting was done over selected mile lengths along the railway line near Shahdara, Karnal, Ferozepur and Khanewal, and also close to gang huts in various railway sections. Over 50 per cent. of these plants are established:

(b) *Treatment of railway embankment at Jhelum.*—The object of this experiment was to stabilise the very steep sandy banks of the newly raised bridge embankment by getting suitable plants to grow on it. About 1,200'  $\times$  20' sloping embankment face was revetted; grass cables were embedded 3' apart along the contours, and wattling completed with rows of dry wooden stakes alternating with live cuttings of *Ipomoea carnea*, 3' apart. 12,000 *Agaves* were planted centrally between the rows. The demonstration has proved convincing to the railway authorities.

(c) *Planting in the mela area in Kurukshetra.*—250 plants were planted for shade and ornament in the mela area. The species used were *Azadirachta indica*, *Bischofia javanica*, *Celtis australis*, *Ficus benamina*, *Kigelia pinnata*, *Melia azedarach*, *Millettia ovalifolia*, *Pistacia integerrima*, *Poinciana regia*, *Pongamia glabra*, *Pterospermum acerifolium*, *Salix tetrasperma*, *Tecoma stans*, *Terminalia arjuna*.

#### (ii) *Natural Regeneration.*

*Cedrus deodara.*—Natural regeneration was abundant in the regeneration areas (Kulu and Seraj). In the deodar crops of the dry zone burnt by the 1921 fires, natural seedlings have appeared under the shelter of mother trees, but in blanks and exposed places only *kail* (*Pinus excelsa*) seedlings (Upper Bashahr).

*Pinus excelsa.*—Natural seedlings were noticed in abundance in regeneration areas, fire blanks dating from 1921, and other places despite grazing. Young plants of *kail* were cut down wherever they interfered with deodar seedlings (Seraj).

*Pinus longifolia.*—Natural regeneration was abundant in the regeneration areas (Seraj). In the experimental plots in unregulated *chil* forests, C. 18 Bhangal (Rawalpindi East), closure to grazing made no significant difference on the influx of natural regeneration.

*Picea morinda* and *Abies pindrow.*—Natural regeneration was good in Seraj division; a quantity of it was noticed in the upper part of Bajrundi (Kulu). In the Lower Bashahr experimental plots, regeneration was found in well drained situations where humus and weeds were not excessive. In the Kulu plots (Research), observations showed that under hardwoods, seedlings were more numerous below unlopped than lopped trees; more numerous in 50' wide than in 75'–100' wide clear-felled strips, and more in 20'  $\times$  30' than larger gaps; also that soil working of some kind is essential, e.g., scraping off humus and exposing the

mineral soil was more effective than working up the humus with the soil, though both gave better results than undisturbed humus.

*Pinus gerardiana*.—Natural seedlings preferred sheltered situations, and were observed under the shelter of rocks, stones, etc. (Upper Bashahr).

*Dalbergia sissoo*.—In the riverain areas (Depôt West), natural regeneration came up profusely, but was wiped out by grazing except in places where bushes provided the necessary protection; prolonged submergence of seedlings under water was also an injurious factor (Depôt West). Regeneration from root suckers was abundant in trenched areas (Depôt West); trenching up to a distance of 1 chain from the mother trees resulted in abundant regeneration from root suckers in Phillaur, and proved helpful in increasing the proportion of *shisham* in the mixed crops (Upper Bashahr).

*Morus alba*.—In the riverain areas, natural regeneration was abundant under *shisham* crops as well as in non *shisham* bearing areas, but seedlings were destroyed by grazing; in Thatla Faqirulla R. F. much damage was done by *nilgais* (Depôt West).

### (iii) Investigation on Seeds.

#### (a) Seed years—

*Abies pindrow*.—Poor (Seraj, Lower Bashahr) moderately good (Kulu), good (Simla).

*Acacia arabica*.—Good (Depôt West).

*Acacia catechu*.—Good (Rawalpindi East).

*Acacia farnesiana*.—Good (Depôt West).

*Acacia modesta*.—Good (Rawalpindi East).

*Cedrus deodara*.—Poor (Kulu, Seraj), moderately good (Lower Bashahr).

*Dalbergia sissoo*.—Good (Depôt West).

*Olea cuspidata*.—Good (Rawalpindi East).

*Picea morinda*.—Poor (Kulu, Seraj, Lower Bashahr), good (Simla).

*Pinus excelsa*.—Poor (Kulu), moderately good (Seraj, Lower Bashahr, Rawalpindi East).

*Pinus longifolia*.—Poor (Kulu, Seraj, Lower Bashahr), good (Rawalpindi East).

*Prosopis glandulosa*.—Good (Depôt West).

*Prosopis juliflora*—

Australian form.—Very good (Research).

Mexican form.—Good at Lahore, poor in Delhi (Research).

Arid form.—Poor (Research).

Argentine form.—Poor (Research).

Peruvian form.—Moderate (Research).

(b) *Seed storage*.—*Calcium carbide* was found very effective in preventing injury to *Prosopis juliflora* pods by *Caryoborus gonagra*, which attacks them readily under storage conditions. A few lumps of *calcium carbide* placed amongst the pods before sealing the tins were sufficient to check the attack (Research).

(iv) *Investigation on Seedlings.*

(a) *Seasonal height growth*.—Measurements of height growth were recorded in research nurseries, the incidence of maximum monthly increment was in July for *Casuarina cunninghamiana*, *Eucalyptus rudis*, *Machura aurantiaca*, *Prosopis juliflora* (Argentine form); in August for *Casuarina lepidophloia* and *Eucalyptus rostrata*; in October for *Acacia arabica*, delayed probably on account of the previous winter's frost damage (Research).

(b) *Frost injury*.—The progeny of Mexican and arid forms of *Prosopis juliflora* raised at Chichawatni and Sambalpani from pods collected from known parent trees of undisputed identification did not prove frost hardy. At Chichawatni the lowest temperature recorded was 28°F. (Research).

(v) *Investigations on Trees and Crops.*

(a) *Phenological Observations*.—Observations were recorded for selected species (Research).

(b) *Water requirements of shisham crops*.—Experiments to determine the depth and frequency of irrigations required for *shisham* crops were continued in Daphar.

(c) *Inheritance of characters*.—For *shisham*, experiments were continued to investigate the inheritance of characters of stem (crooked, forked and straight), leaf size, and time of leaf shedding.

(vi) *Artificial. Regeneration.*

*Cedrus deodara*.—Sowings were carried out over 30 acres (Seraj). In the dry zone, sowings were done under the shelter of stones and in patches protected against the hot sun by means of wooden chips and stones erected round them; results with the

latter method are promising (Upper Bashahr). Sowings failed in Kamra C. 5 and Prindla C. 9 (Rawalpindi East). Planting  $4\frac{1}{2}$  year old seedlings gave good results (Seraj); in the dry zone, winter planting was tried (Upper Bashahr). Over 63,000 seedlings were planted in Kulu, including the restocking of Nagui and Niaragarh areas destroyed by the 1921 fires.

*Abies pindrow* and *Picea morinda*.—Planting was successful in Seraj; and also in the Lower Bashahr experimental plots, but costs did not justify large scale operations (Lower Bashahr).

*Pinus longifolia*.—In C. 85 Jawand R. F. sowings gave only about 30 per cent. success over  $\frac{1}{4}$  acres overgrown with brushwood; growth was cut before sowing and the area fenced; in Guha, only 2 per cent. seedlings of sowings survived in the 2 acres open to grazing as against 20 per cent. in the closed one (Rawalpindi West). Sowings failed in experimental plots (Jhelum).

*Dalbergia sissoo*.—L-cuttings (stumps made from root suckers) were very successful; 27,000 were used locally in the plantations and 28,000 supplied to local bodies and various Government departments (Montgomery). Stumps failed in Jhila Chera, plants being killed by hares and white ants (Rawalpindi East). In the riverain areas, planting at the right time was very important; planting too late in Bela Sahjowal and too early in Bela Jokalian failed. Stumps were successful in Thatta Faqirullah on stiff clay, and in Bela Nurpur Piran (Depôt West). Under a *Eucalyptus* overwood at Changa Manga the growth of *shisham* maintained as an understorey was retarded by the *Eucalyptus* (Tramways).

*Morus alba* and *Melia azedarach*.— $1\frac{1}{2}$  million seedlings were handled in planting operations. In new areas 50 plants per acre were introduced to obtain a mixture; in older crops underplanting was done after the first or second thinning over 2,400 acres (Multan). In Daphar, planting mulberry cuttings after the first rains in areas already stocked with previously planted *shisham* cuttings was found economical (Lahore). All available data on the cultivation of the mulberry has been summarised by Mr. I. D. Mahendru and published as Punjab Forest Records No. 2 (Research).

*Agave species*.—Plants are well established in areas under erosion in Kangra and have appreciably reduced erosion intensity. Bulbils are much more tender than root suckers, which proved exceedingly hardy even after a long journey and considerable exposure. Bulbils should be kept in nursery lines at least a year before being used as transplants (Research). In Jhelum success

was about 50 per cent. in the Chakwal. In Pabbi planting has been done with 70 per cent. success in cool situations, both on the slopes and in the valleys, but only about 40 per cent. plants survived on bunds; heavy casualties on bunds were due to damage by porcupines.

*MacLura aurantiaca*.—The species has been found easy of handling, and promising for underplanting in *shisham* crops on poor soils in the Multan and Montgomery divisions; in Changa Manga however its growth was reported to have been somewhat retarded by the *shisham* overwood (Tramways).

*Opuntia species*.—*Opuntia ficus-indica* has done very well in Pabbi, and *Opuntia dillenii* and *monacantha* in the erosion demonstration plot at Nurpur.

*Parkinsonia aculeata*.—It is well adapted for sandy soils in the plantations, but in Multan division the plants suffered from frost. Sowings are successful at Nurpur in patches and trenches, but seedlings are damaged by hares (Research).

*Prosopis juliflora*.—Only the Argentine form has proved fully frost hardy. Contrary to expectation plants raised from seed collected from trees of Mexican and arid forms have not proved hardy; frost damage was reported from all the divisions in which trial was made with seeds of these forms. Argentine form is indicated as the best in the plantations and arid form in the Kalachitta hills. Sowings of Australian form have been successful in Depôt West division, and its planting in the Phillaur reserve (Upper Bashahr). Plantings of Mexican and Argentine forms also have given satisfactory results in Sambalpani (Research).

*Rhus lancea*.—Sowings in the open did not prove satisfactory, (Multan), but planting has been successful (Montgomery, Research). Height growth is good, but crown development is not sufficiently vigorous to kill out *dab* (Montgomery, Research).

*Schinus terebinthifolius*.—Plants were established but did not prove frost hardy in the plantations (Montgomery, Multan, Research).

*Thuja plicata*.—Planting has been very successful in all the forests, this is much the most promising among the exotic conifers so far tried.

#### (vii) Nursery Work.

Three main nurseries were maintained at Manali, Chichawatni and Sambalpani for research with exotics and indigenous species



which are likely to be of value for silvicultural, afforestation and counter-erosion purposes in the varying conditions in the high hills, arid low hills and irrigated plantations. The study of fodder species, manurial treatments of beds and methods of improving nursery technique also received attention. A large stock of seedlings was raised for distribution to the divisions and other Government departments. Apart from these research centres nurseries were maintained by territorial divisions. At Khanewal, thinning in nursery beds was found very helpful in stimulating vigorous growth of *Morus alba* and *Melia azedarach* seedlings which were thus made available for handling early in the season. Two thinnings were found necessary, the first when seedlings were 4' 6" high to space them 3"-4" apart, and the second again when they were about 1' high to space them 6"-10" apart. With early handling of plants, the beds could also be emptied in time for the next sowings. Trials were made with 34 species. Two *shisham* nurseries were started to meet local requirements for stumps instead of importing them from the plantations (Depôt West).

(viii) *Reclamation and Afforestation.*

At Nurpur, counter-erosion work was started in 1934 in a plot located on a badly eroded slope. Different kinds of plants tried include species noted for thicket forming (*Agaves*, *Alac vera*, *Opuntia*), quick growth (*Acacia catechu*, *Pithecolobium*, *Leucaena glauca*), browse resistance (*Prosopis juliflora*, *Thevetia nerifolia*, etc.), and mat forming grasses. Planting has been augmented by natural seedlings of woody plants and grasses. The area provides a good demonstration of the effect of plant cover in checking erosion, but owing to concentration of road run-off in the nalas, some simple engineering work has also proved necessary to stop further deepening of nala beds. A detailed study was made of badly affected areas in the Jhelum and Kangra districts, and control measures suggested. A comprehensive erosion survey was completed for the Uhl catchment area where control measures are necessary to prevent further degeneration of soil cover and erosion in order to conserve the winter stream-flow which is so necessary for the Hydro-electric Project. Co-operation of Agricultural and Veterinary officers of the Province and of the new Animal Nutrition Section of the Animal Husbandry Research has been sought in assessing the quantity and quality of cut fodder from our closed areas and in the more general problem of the improvement of fodder production from wild lands as a whole. The great possibilities for increased fodder production as the immediate

result of erosion control projects has been clearly proved by our work in Nurpur Kangra, Kalachitta and the Salt Range (Research).

Discharge observations were recorded for streams from the reclamation area in Pabbi for comparing run-off from afforested and non-afforested areas (Lahore). The results have been correlated with torrent discharge data obtained by the Irrigation Branch for this area. The results have been published in *Current Science* (Research).

#### (ix) *Tending.*

Sets of comparative thinning plots were laid out in young deodar crops to study the relative development of stems under differential thinning treatment, and to demonstrate the value of heavy ordinary, crown and free thinnings in young pole and sapling crops (Research). Comparative thinning plots were also laid out in the dry zone in C. 183 above Purbani, where C and E grade thinnings were carried out (Upper Bashahr). *Phulai* was cut in the olive plantation at Murat to favour olive (Rawalpindi West). Heavier thinnings than those done previously were carried out in the plantation crops (Multan). Cleaning at 3 years and thinnings at 6 years were found beneficial in the riverain *shisham* crops of seed, sucker and coppice origins.

#### (x) *Miscellaneous Experiments.*

*Bhabar grass.*—Increase was recorded in the yield of grass in experimental plots (Simla).

*Resin production.*—The effect of the application of hydrochloric acid on the flow and yield of resin was investigated; contrary to expectation resin yield per 1,000 blazes was reduced from 69.5 maunds to 61 maunds with the use of the acid.

*Firewood dryage.*—Weighments at Topa taken during the last 2 years show that the loss in the weight of firewood due to drying was up to 60 per cent. with a 20 per cent. *plus* or *minus* variation on account of weather conditions. It was difficult to apply the figure strictly owing to variations in the weather and the lack of uniformity of the firewood material itself as regards conditions of dryness (Rawalpindi West). These figures have been correlated with dryage data from other departmental depôts collected previously by research staff, and a publication has been issued (Punjab Forest Records No. 3) which should be of considerable value in standardising dryage losses on a reasonable and proved basis, instead of mere guess work (Research).

## II.—STATISTICAL RESEARCH.

*Bamboo plots.*—In the all-India co-operative experimental plots in Hoshiarpur, fellings were carried out in the sub-plot worked under a 3-year felling cycle, and necessary measurements recorded. Observations show that the size and number of new culms produced is greater in clumps opened under heavy thinnings than in relatively congested clumps (Research).

*Sample plots.*—A replicated set of comparative thinning plots was laid out in Kulu in young deodar crops; individual stems were classified according to Craib's crown classes. The analysis of data showed that growth vigour was correlated with the crown class of trees. The results were presented at the 1937 Punjab Forest Conference (Research).

Sixty-one sample plots were remeasured, 35 in Kulu, 9 in Seraj, 12 in Multan, 3 in Tramways, and 2 in Lahore division. Of these 6 were felled and fully measured, 4 in Multan and 2 in Lahore division (Research).

Maps were prepared showing the position of sample plots distributed throughout the province. History sheets were completed for all the plots, giving crop data for each plot for ready reference (Research).

Appendix I gives the distribution at the close of the year of all the sample plots in the province.

*Single tree data.*—Single tree data collected by territorial divisions was checked and sent to Dehra Dun for computation. Summary results were kept posted to date in Form No. 10.

## III.—MISCELLANEOUS.

*Rainfall data.*—Rainfall statistics collected in the territorial divisions were maintained and a consolidated annual statement prepared (Research).

*Photo collection.*—Indexing and filing of photographs of forest and publicity value was continued. The total collection as it stood at the end of the year was 1163 negatives, 1556 prints and 284 lantern slides.

Lantern slides were arranged in sets to facilitate their issue for publicity work which is being carried out in co-operation with the Rural Reconstruction Department (Research).

*Records.*—12 specific and 2 general files were opened. The total number now stands at 154 specific and 327 general files (Research).

*Library.*—133 new publications were added in addition to serial bulletins and periodic literature on forestry subjects (Research).

*Working Plans.*—The position with regard to new plans is as under:—

*Working plans and schemes completed—*

Arafwala Plantation Working Scheme.

*Working plans and schemes under preparation—*

Working plan for—

Changa Manga.

Daphar.

Simla Municipal Forests.

Throach State.

Working scheme for the belas in the Chenab and Jhelum rivers.

*Erosion and forestry models.*—A set of three models showing the bad effects of forest destruction, and subsequent erosion has been prepared and is being duplicated for use in (a) Lahore Museum (b) Commissioner Rural Reconstruction's permanent exhibit at his office (c) demonstrations at farmers' weeks, fairs, melas and other exhibitions (Research).

*Staff.*—Dr. R. M. Gorrie was in charge of Research division throughout the year. Messrs. I. D. Mahendru and R. S. Chopra remained attached, the former worked as general assistant for all divisional work and in charge of the railway planting; the latter in charge of sample plot measurements and research work at Chichawatni and Sambalpani.

Bh. Gurbachan Singh, Forest Ranger, was in charge of works in Kulu, and L. Chaman Lal, Forest Ranger, of works in Nurpur and miscellaneous duties at headquarters including demonstration of models.

## UNITED PROVINCES.

## I.—EXPERIMENTAL SILVICULTURE.

(i) *General.*

As sal forests are the most valuable and the most extensive of our commercially exploitable forests the problem of sal regeneration continues to be the most important item of silvicultural research and experiment. The number of sanctioned experiments under the Silviculturist was 56, the same as last year, and 3 new ones were being laid out at the close of the year. A few of the old experiments are being converted into preservation plots. The number of divisional experiments was 52, two old experiments were written up and closed and 22 new ones opened, the majority of which deal with the *de novo* regeneration of sal.

(ii) *Natural Regeneration.*

## (a) From Seed.

2. *Shorea robusta* (sal).—There really is not much to add to what was stated last year concerning the development of whippy and woody plants when given adequate overhead light, protection from browsing, and protection from weed competition. The position up to date is adequately summarised in Mr. Smythies' article in April 1936 *Indian Forester* and Mr. Mobbs' article in August 1936.

Fencing, when sufficiently adequate, seems to be more beneficial to regeneration that is regularly burnt than to regeneration that is regularly shrub cut. In fact deer browsing may in some cases be beneficial in keeping down weeds and shrubs in areas regularly shrub cut. In unfenced areas, however, deer do much more damage in weeded lines than in unweeded areas. Shrub cutting appears to help sal both in height growth and stocking better than burning in practically all conditions and brings in grass quicker. Severe burning seems to cause considerable die back, although this is probably no greater than occurs in areas of heavy undergrowth which cannot be burnt properly and in which the sal is smothered. It does appear, however, that subsequent development is much hindered by excessive canopy and in some divisional experiments steps are being taken to reduce the canopy.

3. The Silviculturist completed a final layout in the series of large scale experiments in the North Kheri damar (Champion's type

B. 3). In this the area was fairly adequately stocked with small seedlings which had not yet reached the whippy stage. In the new divisional experiments to attempt the *de novo* regeneration of sal for one reason or another, poor soil, excessive rain, etc., practically all the fresh seedlings obtained died during the first year. The experiments will continue.

Arrangements are being made in all the large fenced experiments for individual seedling study to observe fluctuations caused by die back and to trace the progress from recruitment to the whippy stage.

(b) From Coppice.

4. *Acacia arabica* (babul).—A mild year for frost and good rains were beneficial to the babul coppice in Etawah in that the surviving shoots developed well, but mortality from previous frosts has now risen to 64 per cent.

5. *Hill oaks*—*Quercus incana* (banj).—Coppice, freed from overhead cover is developing well and shows a height increment from 58" to 66", but after eight years is not yet free from browsing or suppression by undergrowth. *Quercus lanuginosa* (rianj) also shows similar development but *Quercus dilatata* (tilonj) coppices very poorly only about 9 per cent. of the original coppice still surviving.

(iii) Seed Supply.

6. The Clutterbuckganj seed store continued to collect, distribute and arrange for indents of seed. The largest demands were for Burma teak (56 maunds) and mulberry (21 maunds). Germination tests were made on all seed handled.

7. *Acacia arabica* (babul) continued quite viable after seven years of ordinary storage. Seed from 3-year old *Dalbergia sissoo* and 4-year old *Albizia lebbek* germinated well. *Pinus caribaea* seed from Florida (via the Forest Research Institute) give only 18 per cent. germination in nursery beds.

(iv) Nursery Work.

8. *Pinus caribaea* seedlings, after poor germination, largely damped off in the rains and the few survivors were too weak to last through the hot weather.

(v) Artificial Regeneration.

9. Artificial regeneration on a large scale has now become a routine measure in many divisions both with and without *taungya*.

*Shorea robusta* (sal).—There is nothing special to report. Provided advantage is taken of the accumulated knowledge on the subject and areas suitable for growing sal are chosen, there is no difficulty.

10. *Acacia catechu* (khair).—The few cuttings that survived in the Lalkua experiment have been almost entirely wiped out by browsing and grass competition. It may be taken as definite that the best way to regenerate this species artificially is by sowing.

11. *Pollinidium angustifolium* (baib or sabai).—The Ujhani plantation now six to eight years old gave a yield of about 21 maunds (one day dried) per acre chiefly owing to a favourable monsoon. A considerable quantity of natural regeneration has come in.

The divisional experimental baib plantations in Pilibhit and South Kheri have proved very profitable especially the latter; in the former division considerable damage was done by the excessive rains in 1936. In South Kheri there is a parallel experiment to determine the optimum spacing which at present appears to be 2' x 2'. These experiments will shortly be written up. On suitable areas baib is easily and profitably propagated.

12. *Santalum album* (sandal).—No further sowings were made by the Silviculturist. By regular weeding clumps of healthy sandal have been raised, mostly from the 1933 and 1934 sowings, the best being up to 10' high. In Jhansi recruitment continues but mortality is rather high. This is possibly due to the unsatisfactory condition of the hosts. Sowing and planting is now being tried with suitable hosts.

13. *Tectona grandis* (teak).—The all-India teak seed origin experiments continued satisfactorily. In Gorakhpur the plots were thinned and turned into sample plots. In Haldwani as there was practically no frost better growth was put on, but the general form is very poor.

#### (vi) Reclamation and Afforestation.

14. *Usar*.—Leaflet No. 8 recently published gives an up-to-date account of the Makhdumpur experiment. Owing to favourable rains in 1936 the yield in one plot increased to as much as 20 maunds per acre. In Partabgarh District a small scale experiment to afforest mild *usar* with well tried species with irrigation by percolation was begun.

15. *Bhur*.—Nothing new to report. The good rains of 1936 did much good to most of the experimental plantations on *bhur* areas.

(vii) *Tending.*

16. Nothing new to report.

(viii) *Mixtures.*

17. In the Saharanpur *taungyas* where mixtures of commercial and lopping species are being grown, it seems best to mix species by lines, rather than in the lines.

(ix) *Underplanting.*

18. Nothing new to report.

(x) *Silvicultural Systems.*

19. Nothing new to report.

(xi) *Miscellaneous.*

20. The resin tapping experiment at Garhkheth in Almora continues. Results are not definite but it appears that deep (2") tapping is most productive and that twisted fibre trees give a higher yield than straight fibred trees. A small experiment of treating blazes with a 20 per cent. solution of hydrochloric acid gave at first an increased yield followed by a considerable decrease.

## II.—WORKING PLANS AND STATISTICS.

(i) *Working Plans.*

21. Working plans for the Haldwani, Jhansi and East Almora divisions and for Landour and Lansdowne Cantonment forests were completed during the year. Working plans were in preparation for the Naini Tal, Lansdowne and Saharanpur divisions and for the Muktesar Laboratory forests. Preliminary working plan reports were written for the South Kheri division and the Mussoorie Municipal forests. During the working season preliminary reports were also written for the Garhwal division and the Pauri (Garhwal) Fuel, Charcoal and Timber Supply plan.

(ii) *Field Tables.*

22. Sixty-three permanent sample plots were remeasured and six new plots in plantations were laid out. Six more linear sample plots, totalling seventeen miles, were laid out in Champion's sal types B3, B4 and A2, the two latter being new types hitherto not taken up. The total number of linear plots is now 36, with a total of over 58 miles in five different types.



(iii) *Bark Measurements, etc.*

23. Nothing to report.

(iv) *Miscellaneous.*

24. The fourth edition of the Forest Pocket Book by Mr. S. H. Howard, I.F.S., was published during the year. Four more leaflets, " Porcupine Proof Fencing ", " An Approximate Volume Table for *haldu* ", " Second Interim Report on the Makhdumpur *Usar* experiment " and " Record of Seeding of the Common Tree Species in the U. P. " were issued during the year.

25. The staff employed on Silvicultural and Statistical research work consisted of the Silviculturist, the Assistant Silviculturist, one forest ranger, two deputy rangers and two foresters.

## CHAPTER III.

### FOREST BOTANY.

#### ASSAM.

##### I.—OECOLOGY.

The collection of specimens from the sal forests of Goalpara was continued but little progress was made for want of staff and funds. Nowadays owing to the numerous duties which a Divisional Forest Officer and his staff have to carry out, they have little time to devote to the collection of specimens. It is hoped, however, that during the revision of the Goalpara and Kamrup working plans the Officer-in-charge will be able to collect data for this very important work.

Collections of plants have been made in the interesting relict forests of the Shillong plateau in order to determine what is the actual climax forest of the Khasi and Jaintia Hills above 4,000'. These relicts have been preserved from time immemorial because they are places of worship or the abode of evil spirits; no trees are cut, no cattle grazed or any disturbance of the vegetation allowed to take place. The advent of Christianity (as a result of which all interesting beliefs and customs are thrown overboard) threatens the existence of these primeval patches of forest and it may be that the investigation has only just been started in time. A preliminary examination shows that the true climax is not pine forest (Champion, Types of Forest Vegetation in India) but high forest of broad leaved evergreen species in which the families *Lauraceæ*, *Fagaceæ* and *Magnoliaceæ* predominate.

##### II.—SYSTEMATIC.

##### *Herbarium work and other Investigations.*

Plates of several species of *Phæbe* and the three new species viz., *kaula* (Nowgong), *mékahi* (Sadiya) and *Eugenia* (N. C. Hills) have been prepared and sent to the printers who now await the descriptions in order that they may be published in the Assam Forest Records.

Mr. Purkayastha submitted the descriptions of four new species to the *Indian Forester* for publication, viz., *Salacia khasiana*, *Quercus milroyi*, *Ilex khasiana* and *Purkayasthaea micropora*; the

latter being a new genus and species close to *Micropora* (*Lauraceæ*). He has also been investigating a species of *Eugenia*, which may very well turn out to be a new species, and complete material has been sent to Kew for report.

The herbarium has been maintained in good condition. Very great progress has been made up in the mounting of old specimens, some of which were collected over 30 years ago. The collections have been enriched by about 3,500 sheets collected by the writer (Dr. Bor) in the Aka and Naga Hills. These collections have shown that our knowledge of the flora of Assam is very far from complete. In addition to the new species mentioned above there have been many interesting new records, viz., *Petrocosmea parryorum* C. E. C. Fischer (Lushai Hills); *Oryzopora serrata* Diels, *Lasianthus sikkimensis* H.f. (Sikkim); *Aconitum elwesii* Stapf. (this plant is now in cultivation at Kew; found on Chingkhlu, Naga Hills); *Pottingeria acuminata* Prain; *Dioscorea kamoonensis* Kunth var. *stamina* Prain et Burk; *Gardenia coronaria* (Chittagong); and several others.

The genus *Aconitum* was stated in Volume I, Part I, Flora of Assam, to be absent from the province. There are, however, at least three species, viz., *Aconitum nagarum* Stapf. (Japvo, Naga Hills), *A. elwesii* Stapf. (Chingkhlu, Naga Hills) and *A. lycotonum* Linn. (Aka Hills). As the Daffas are accustomed to tip their arrows with aconite, there must be another species in these hills as the last named plant is non-poisonous.

It is, however, in the family *Gramineæ* that very real progress has been made. The writer spent 6 months in the Kew herbarium in 1936 by the courtesy of Sir A. Hill, the Director, and had the able advice of Mr. C. E. Hubbard, the Agrostologist. All the sheets of *Gramineæ* were identified in the Kew herbarium and intensive collection has proceeded during the past two years. The result of this has been a singularly complete collection of Assam grasses. Several species not collected since C. B. Clarke left the hills over 50 years ago, have been rediscovered and four new species are about to be described.

In connection with grasses, the most noteworthy event of the past few years has been the introduction of fodder grasses into Shillong. Common English species such as *Phalaris arundinacea*, *Anthoxanthum odoratum*, *Lolium perenne*, *Arrhenatherum elatius*, *Holcus lanatus*, etc., have spread all over the station and in one case the first named has been found 16 miles away. The Agricultural Department have introduced *Panicum maximum*, *Pennisetum purpureum* and several others.

Throughout the year the greatest assistance has been rendered by the staff of the Royal Botanic Garden, Kew, that of Sibpur, and the Forest Botanist, Dehra Dun, and they have placed us under a very great obligation.

A large amount of identification work was carried out for Divisional Forest Officers during the year. The work of poisoning the collections was carried out as far as possible.

Duplicate herbarium sheets were distributed as follows:—

Royal Botanic Gardens, Kew . 4 sheets of rare grasses.

Herbarium of the Federated Malay States. Complete flowering and fruiting materials of *Shorea assamica*.

The following herbarium materials were lent for study to other persons and institutions:—

Mr. A. Das, Late Botanical Officer. Sheets of important species of the groups *Gamopetalae* and *Apetalae* for teaching Botany to the students of the Lady Kenne Girls' College, Shillong.

Seeds of the following species were supplied as follows:—

*Coffea khasiana* . . . . To Royal Botanic Garden, Sibpur, for supply to institutions outside India.  
*Tephrosia candida* . . . . To Plant Pathologist, Bombay Presidency, Poona.

New exchange relations were opened with the following and publications and herbarium materials were received and distributed mutually:—

- (1) Prof. S. P. Agharker, Botany Department, University College of Science, Calcutta.
- (2) Director of Gardens, Straits Settlement, Singapore.
- (3) Forest Botanist, F. R. I., Kepong, Selangor, Federated Malay States.
- (4) Prof. T. Tanaka of the Imperial University, Taihoku, Formosa, Japan.

Various enquiries of scientific and economic importance were dealt with by this herbarium through the Conservator, Divisional Forest Officers and Institutions and other concerns in and outside India.

Dr. E. K. Janaki Ammal, Geneticist, Sugar Cane Station, Coimbatore, paid a short visit to the herbarium during the year.

The herbarium continues to justify its existence and is constantly and increasingly used for reference not only by local officers but also by scientific Institutions in India and in other parts of the world.

### Staff.

The post of the Botanical Officer was held by Mr. C. S. Purkayastha, Deputy Conservator of Forests, till November 1st, 1936, when Dr. N. L. Bor, D.Sc., I.F.S., took over the duties. He held the charge for the remaining period of the year.

The staff carried out the usual routine duties and all collections made during the year were dealt with. Proposal for confirmation of the staff is under the consideration of the Government.

### III.—PATHOLOGY.

A specimen of *Leersia hexandra* Sw. was sent to the Mycological Laboratory, Kew, where it was found that the spikelets were infected with *Testicularia leersiae* Cornu, a fungus hitherto only known from Africa. A species of *Peridermium* was discovered on the needles of *Pinus khasya* hitherto unknown as a host. This fungus is being investigated by Dr. Bagchee, Forest Mycologist.

### IV.—PUBLICATIONS.

Printing of Part II, Volume I, of the "Flora of Assam" was finished during the year.

The report on the known poisonous plants of Assam was submitted during the year, and to make it as useful as possible in its next edition further attempts are now being made to collect complete botanical specimens of the species whose vernacular names could only be mentioned therein at the time.

### BENGAL.

Work on the revision of the Chittagong flora could not be undertaken during the year.

Dehra Dun continues to give valuable assistance in the identification of doubtful and unknown specimens.

No work other than the compilation of a list of some of the known medicinal plants could be undertaken during the year. Owing to lack of staff and proper facilities and equipment this wide field of investigation cannot be tackled.

## BIHAR.

## I.—ECOLOGY.

*Soil Samples.*

## Saitba Sabai Plantation, Kolhan Division.

Four samples of soil were sent to the Agricultural Chemist, Sabour, from Kolhan division, Saitba *Sabai* plantation, for analysis. The results are tabulated below :—

| Lab. No. | Description of samples.   | Molsture. | Loss on ignition. | Total organic Nl. | Available P <sub>2</sub> O <sub>5</sub> . | Available K <sub>2</sub> O. |
|----------|---|-----------|-------------------|-------------------|---|-----------------------------|
|          |   | Per cent. | Per cent.         | Per cent.         | Per cent.                                 | Per cent.                   |
|          | Soil samples from Kolhan Forest division <i>sabai</i> plantation— |           |                   |                   |   |                             |
| 712      | 0-3" . . . . .  | 1.10      | 7.38              | 0.32              | 0.0011                                    | Traces.                     |
| 713      | 3"-9" . . . . .   | 1.11      | 0.01              | 0.101             | Traces                                    | Do.                         |
| 714      | 9"-18" . . . . .  | 1.46      | 5.33              | 0.078             | Do.                                       | Do.                         |
| 715      | 18"-36" . . . . .   | 0.94      | 5.48              | 0.059             | Do.                                       | Do.                         |

The soils contain negligible quantities of available mineral nutrients but are rich in nitrogen and organic matter. From the general appearance and texture of the soil it appears to be *subjected to erosion*.

There is plenty of nitrogen, the essential nutrient for *sabai* plantation and an addition of phosphatic and potassic fertilisers especially phosphate is desirable. An experiment has been laid out on these lines.

## Debour—Rajauli Road East of Singirichi Hill.

Three samples of soil labelled (1) top (no sal), (2) along road side (sal), (3) middle (sal) respectively. The analyst was requested to find out why no sal regeneration was to be found growing in No. 1 soil, and only a small quantity in sample No. 3. The result of analysis is given below and compared with the results of mechanical analysis of sal area in the New Forest and coppice area

of Lachiwala sal forest where very little natural regeneration is reported to take place:—

|                                   | Bihar soil<br>No. I top<br>(no sal). | Bihar soil<br>No. II along<br>road side<br>(sal). | Bihar soil<br>No. III<br>middle<br>(sal). | Sal area<br>New Forest,<br>F. R. Insti-<br>tute, Dehra<br>Dun. | Coppice<br>area Lachi-<br>wala, Dehra<br>Dun Divn. |
|-----------------------------------|--------------------------------------|---|---|--|--|
| Stones & gravels . . .            | nil                                  | nil   | ..  | ..   | ..   |
| <i>Fine earth.</i>                |                                      |   |   |  |  |
| Coarse sand, per cent . .         | 11.31                                | 44.12   | 28.12                                     | 27.5   | } 7.6  |
| Fine sand, per cent . .           | 28.20                                | 10.17   | 28.24                                     | 20.0   |  |
| Silt, per cent . . .              | 18.20                                | 14.30   | 13.75                                     | 35.8   | 72.5   |
| Clay, per cent . . .              | 32.40                                | 18.40   | 24.80                                     | 9.0  | 17.7   |
| Moisture, per cent . . .          | 4.25                                 | 2.12  | 3.33                                      | 1.3  | 1.5  |
| Loss by solution, per cent .      | 2.40                                 | 1.00  | 1.73                                      | ..   | ..   |
| Difference, per cent . .          | 0.03                                 | 0.83  | 0.03                                      | 0.4  | 0.7  |
|                                   | 100.00                               | 100.00  | 100.00                                    | 100.00   | 100.00   |
| Organic matter (loss in ignition) | 4.00                                 | 2.31  | 3.48                                      | 3.10   | 8.0  |
| Class of soil . . . .             | Light clay.                          | Sandy clay<br>loam.                               | Sandy clay.                               | Loam.  | Silty clay<br>loam.                                |

The above analysis shows that soils I and III are rather clayey soils and No. II, although clayey, is of more open texture but none of these bears any comparison with the New Forest soil which is very much open in texture. The Lachiwala soil is inferior in texture to the No. II soil and although less clayey than No. I and No. III soils it may be considered as of inferior texture in so far that it contains very high percentage of silt and very little of sand.

#### *Soil moisture tests.*

Bamiaburu and Sangajata, May 1937.

The differences in soil moisture within and without the irrigated areas are seen from the following moisture tests carried out on samples of soil taken on May 6th, the hottest time of the year. The first sample was taken at Bamiaburu itself just below and to the south-west of the bungalow, not under direct influence of any channel irrigation. The second sample was taken at Sangajata six miles to the south and outside all irrigated influence. Both were taken in road cuttings, three inches below the top surface of the soil and 8" into the bank. The Bamiaburu sample shows 6.10 per

cent. moisture as against 3.23 per cent. at Sangajata. Hole, some years ago in his "Regeneration of Sal experiments" said that there should be 5 per cent. moisture in the soil for sal growth to take place. The Bamiaburu sample fulfils that condition. This may explain why sal seedlings are coming in so profusely and not dying back the following year.

## II.—SYSTEMATIC.

*Nil.*

## III.—PATHOLOGY.

Insect attacked plants of *Aleurites fordii* and shoots of *Cedrela toona* were sent to the Forest Research Institute for identification.

For the former the Forest Botanist remarked that the plants show pink to black coloured rots in their collar region, the tissues of the collar portion being heavily infested with hyaline to dark coloured hyphae. As no fruit bodies of fungi were found with the rot, identification of the fungus was not possible. Instructions have been given to the Forest Ranger in charge of the Hino Experimental Garden to find out plants in a dying condition, complete if possible above and below ground, with fructification, for identification purposes.

As regards *Cedrela toona*, the Entomologist identified the insect to be *Hypsipyla robusta*, Moore (*Pyralidae*). For the life-history see Indian Forest Record, Volume VII, Part VII of 1919.

## BURMA.

The post of Forest Botanist remained unfilled. The Silviculturist (Mr. C. W.-D. Kermode) held charge of it in addition to his own duties.

Maung Kan, Curator, was in charge of the herbarium throughout the year. He was assisted in his work during the rains by Foresters of the Silviculturist's staff. Mr. Kermode reports as follows:—

Three hundred and one botanical specimens were mounted during the year bringing the total to 39,399 sheets in the herbarium at the close of the year. Cleaning and poisoning of specimens was done by the Silviculturist's staff, during the rains. There is a good deal of damage which was mainly done by insects when the herbarium was in Rangoon. There are few signs of fresh damage. A considerable number of partially named specimens was sent to Calcutta and Dehra Dun for naming by these institutions



and those for which identifications have been received have been added to the herbarium. One hundred and twenty-nine specimens of ferns were sent on loan to the Curator, Royal Botanic Garden, Calcutta, for examination. These have been examined by him at Kew and have been returned named or confirmed. A further recent collection of ferns together with a number of old herbarium sheets of fern allies have recently been sent for examination.

Specimens were distributed to the following:—

- (1) Forest Botanist, Forest Research Institute, Dehra Dun. Three sheets of *Quercus* spp.
- (2) Curator, Philippine National Herbarium, Bureau of Science, Manila. 52.
- (3) Curator, Royal Botanic Garden, Sibpur. 30.
- (4) W. W. Howard & Co., London. Two sheets of Burma padauk (*Pterocarpus macrocarpus*).
- (5) Botanical Museum of Harvard University. Two sheets of *thitsi* (*Melanorrhœa usitata*).

70 lbs. of acorns of *Quercus serrata* (nyan) were supplied to the Chief, Division of Management, Pretoria, South Africa.

We are especially indebted to Mr. C. E. Parkinson, Forest Botanist, Forest Research Institute, Dehra Dun, for a collection of 186 botanical specimens for our herbarium.

Contributions were also received from:—

- (1) Mr. H. C. Smith, Conservator of Forests, Chindwin Circle, Maymyo. A collection of specimens made on Mt. Popa in October 1936. These have not yet been named. A collection of specimens made by Mr. Smith in Padaung Reserve, Myitkyina, in March 1936 has been named partly here and partly at Calcutta.
- (2) Mr. G. S. Shirley, Conservator of Forests, Northern Circle, Maymyo.
- (3) Mr. D. J. Atkinson, Conservator of Forests, Utilization Circle, Rangoon.
- (4) Mr. C. W. D. Kermode, Silviculturist, Maymyo.
- (5) Mr. W. C. F. Carroll, Divisional Forest Officer, Southern Shan States.

A good deal of the Curator's time was occupied in mounting, writing up labels, disinfecting specimens and in despatch of specimens to other herbaria for comparison and naming. He has now started on a classification of the herbarium with the object of, as

far as possible determining the distribution of the species collected. When this has been completed it is hoped that it will serve as a basis for a revised edition of Lace's "List of Trees, shrubs, etc., in Burma" which is now out of date. Identification of a number of specimens sent by local officers has been done by the Silviculturist, Maymyo.

A collector, Maung Po Khant, formerly a forester on the staff of the Forest Botanist, was sent out to the Wa States with the Sino-Burma Boundary Commission. He returned after the close of the year with a collection of 140 botanical specimens as well as a number of orchids. The thanks of the Department are due to the Officer in charge for permitting the collector to accompany the expedition and for arranging for his transport. The collection should be of interest, as it is believed that this region has not been botanically explored.

32. *Botanical Gardens—Charge.*—Mr. C. T. Bogg, Superintendent, was in charge throughout the year. He also held additional charge of the Government House Gardens, Maymyo.

*Municipal Contribution.*—The Maymyo Municipality again contributed Rs. 1,200 towards the maintenance of the garden, which sum was included in the total grant for upkeep.

*Visitors.*—His Excellency the Viceroy of India honoured the garden with a visit during his last official visit to Burma. His Excellency expressed himself as being pleased with the lay out and showed interest in the orchid collection and fruit producing plants. His Excellency the Governor and Lady Cochrane were also frequent visitors.

That the garden is appreciated, there can be no doubt, judging by the number of visitors, especially those from the mofussil.

*Progress.*—Much useful work was accomplished during the year.

A new "Sulky" mower was purchased at a cost of Rs. 800 which made it possible to maintain the entire lawn area of the garden in a satisfactory manner. The new machine is extremely light and easily worked, with little or no strain on the bullocks, with the result, that what used to take a month to cut with the old type of mower, can now be cut in 10 days.

*Roses.*—The rose garden, which has proved a decided attraction, was re-arranged and several new varieties of roses imported from England were added to it.

*Shrubberies.*—250 shrubs were planted to fill up vacancies of the past five or six years.

*Buildings.*—The mower godown was rebuilt at a cost of Rs. 257. The remaining buildings were earthhoiled and maintained as usual.

*Roads and Paths.*—In the *Rosaceæ* area, 693 feet of paths were treated with Colas. The remaining paths and roads were weeded more frequently, though at a greater cost. This is an item of expenditure which will tend to decrease with the gradual tarring of all roads and paths.

*Water Supply.*—The water supply plant was worked for 253 hours at a cost of Rs. 670-4. Of this sum, Rs. 480 was for driver's wages; Rs. 149-15 for fuel and lubricating oil and Rs. 40-5 for other running charges.

*Systematic Work.*—Advantage was taken of favourable conditions to plant out several representative species in their respective family plots. 118 plants were put out.

The number of plants now in their correct family plots to the end of March 1937 is 1,487, representing 56 families, 256 genera and 513 species.

*Orchids.*—Visitors continue to show considerable interest in the orchid house in which there are now 166 named species.

*Acclimatization—Plants.*—There has been an appreciable demand for flowering trees and shrubs and consequently, a new plant catalogue, with additional sections for fruit trees and orchids, has been printed and distributed.

*Season.*—The season was not as favourable as last year, though the rainfall, 56·14" was up to average. The early cessation of the rains in October resulted in plants not being able to stand up to the heavy and persistent frosts of January and a number of plants were badly damaged, particularly, *Jacaranda*, *Cannas*, *Erythrinas* and *Millettias*. The lake also suffered and started to decrease earlier than usual.

*Flower Show.*—On the recommendation of the Garden Advisory Committee and under the Chairmanship of Mr. T. H. G. Bostock, the Maymyo Flower Show was held at the end of March 1937 after being in abeyance for six years.

*Finance.*—The revenue realised was Rs. 1,477-13, which is a record for the garden. The expenditure was Rs. 18,055-6 against an allotment of Rs. 18,173. Establishment accounted for Rs. 9,359-5 and maintenance Rs. 8,696-1. Under establishment, Rs. 1,200 was leave-salary of the late garden Overseer. Actually,

the nett cost to Government for the Botanical Gardens during the past year has been the lowest on record, after taking revenue into consideration.

## CENTRAL PROVINCES.

### I.—OECOLOGY.

57. *Preservation plots*.—According to the list published in the triennial programme for 1936-39, there were 9 plots in the province at the beginning of the year. Judged from the standard now required for such plots, however, at least 5 of these will have to be abandoned, and the records of the remainder entirely rewritten.

The aim is to eventually lay out a few plots in each of the important forest types of the province and Mr. Champion's "Preliminary survey of forest types of India" is taken as the basis of classification. Certain modifications are, however, necessary in the terminology to suit local conditions. The most important of these is the omission of the sub-division of a group into Northern and Southern counterparts. As the Central Provinces lie in the transition zone this differentiation is nowhere noticeable and is in fact very confusing. As against this we have three well defined sub-groups, *viz.*, mixed forest without teak or sal which is the basic type, and its several phases with preponderance of teak in the northern, western and the central part of the province and the preponderance of sal in the eastern part. A note setting forth the proposed modifications is under preparation. In the meanwhile selection of suitable areas for laying out the plots has already been taken in hand.

58. *Karka bamboos*.—The dense and switchy growth of *Dendrocalamus strictus* bamboo near Muki in Balaghat which has hitherto been considered a dwarf variety of the species, is now observed to be gradually forming into clumps and growing like the ordinary bamboo, showing clearly that the thicket like growth for a somewhat longer period than usual was probably due to a very prolific seeding and to the exceptionally favourable conditions for its regeneration under a light cover of sal.

### II.—SYSTEMATIC.

59. *Crinum latifolium* was found growing fairly extensively in the Banjar reserve of Mandla. This species had been located previously at Burghat in the Melghat and at Ladi in Betul.

*Careya herbacea* a very common plant in sal *maidans* is also found to occur at Mowar in Betul. In the latter place it was

noticed to flower in May and not in June-July as mentioned in Mr. Witts Flora.

60. Seeds of *Cassia fistula* collected in Balaghat and Chhindwara were found to be noticeably different in size as well as shape. The former are big and tapering while the latter are small and oval. Plants are being raised from the two varieties separately to see if there is any difference in them.

### III.—PLANT PATHOLOGY.

61. *Fomes pappianus* is very prevalent in the older *Babul* bans of Amraoti. This is chiefly attributed to early congestion in the crop which weakened the plants. Subsequent unfavourable soil-moisture conditions have helped the spread of the fungus. The best preventive measure is to sow lightly and then to start thinning from the second year onwards.

## CHAPTER IV.

### FOREST ENTOMOLOGY.

#### BENGAL.

Intensive spraying with a mixture of tobacco, soap and water was carried out to control the pest *Urostylis punctigera* for the 2nd year in succession in *champ* plantations without any effect. It is hoped that investigations on the biological control of this pest will be taken up in future by the Forest Entomologist, Dehra Dun.

#### BOMBAY.

A species of *Amsacta* caused heavy defoliation of teak in the first week of July 1936 between Birchi and Dandeli in Kanara N.-D. The insects, however, disappeared suddenly with the advent of heavy rain and as no chrysalises could be collected the identification of the moth was not possible. This species has not previously been recorded to feed on teak and was observed for the first time during the last 8 years.

The larvæ of *Zeuzera coffeæ* were observed on a few sandalwood plants in Siddapur coupe in the Sambrani range. The insect did not spread and no particular damage was noticed. This borer has been recorded as attacking sandal but not to any great extent.

#### BURMA.

##### A.—PESTS OF TEAK.

##### I.—*Xyleutes ceramica* Wlk., the Beehole Borer.

##### (a) Life History.

*Life History Observation Plot at Thogale, Pyuchaung Reserve, South Toungoo division—*

*1935 generation.*—It was found that only 9 larvæ or 9·2 per cent. of the original attack had survived to pass into their second year, and these had all failed by January 1937. The original attack, i.e., number of new beeholes recorded in June and July 1935, was 98. Subsequently 61 additional beeholes were recorded, but these must be put down as transfers, as it would not be possible for a larva to go undetected in the plot until September. 9 moths (8 males and 1 female) or 9·2 per cent. of the original larval population emerged in March 1936; no second year moths emerged in 1937.

*1936 generation.*—In June 28 beeholes of the new generation were recorded. When the plot was next visited, in August, 6 of these had failed, but 62 new larvae were found, bringing the total original attack to 90. By September 35 more had failed; but 20 beeholes, hitherto unrecorded, were found, which must have been transfers from holes recorded as failed. The larval population of this generation, which started with 28 larvae in June, rose to 84 in August, subsequently falling away to 69 in November, 58 in January 1937, 37 in March 1937, and between 10 and 15 are expected to survive into their second year.

Three moths, 2 males and 1 female, emerged in March after one year.

*Data from Observation Plot Records—*

(i) *Annual incidence.*—The total number of beeholes of the 1936 generation (original attack *plus* transfers) was 129 and is compared with the attack in previous years in the following table:—

| Year.<br>(1)                  | 1930.<br>(2) | 1931.<br>(3) | 1932.<br>(4) | 1933.<br>(5) | 1934.<br>(6) | 1935.<br>(7) | 1936.<br>(8) | Period<br>1930 to<br>1936.<br>(9) |
|-------------------------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|-----------------------------------|
| Total beeholes re-<br>corded. | 1,102        | 409          | 545          | 701          | 78           | 150          | 129          | 2,094                             |
| No. of trees in plot          | 247          | 240          | 240          | 245          | 243          | 243          | 241          | 245                               |
| Average beeholes per<br>tree. | 4.40         | 1.00         | 2.27         | 2.86         | 0.32         | 0.65         | 0.53         | 2.04                              |

(ii) *Correlation of annual incidence with moth emergence inside the plot.*—The following table shows the record of moths emerging from trees in the plot from 1932 onwards:—

| Year.          | Moths. |         |                | Total. |
|----------------|--------|---------|----------------|--------|
|                | Male.  | Female. | Sex not known. |        |
| 1932 . . . . . | 6      | 3       | 2              | 11     |
| 1933 . . . . . | 8      | 4       | ..             | 12     |
| 1934 . . . . . | 6      | 1       | 1              | 8      |
| 1935 . . . . . | 5      | 1       | ..             | 6      |
| 1936 . . . . . | 8      | 1       | 1              | 10     |
| 1937 . . . . . | 2      | 1       | ..             | 3      |
| TOTAL          | 35     | 11      | 4              | 50     |

These figures represent an average moth emergence of 4.7 per cent. of the original attack in each generation. Comparing this with the table in paragraph (i) above, it will be seen that

there is a correlation between female moth emergence in the plot and larval population in the same year. Studies of the habits of the female moth itself will have to be made before it can be known how much ground one female covers during oviposition; attack in 1934, 1935 and 1936, when only one female per annum is known to have emerged, was widespread over the 245 trees in the acre plot. Such oviposition habits as have been studied suggest that the female, having found a place to her liking, remains there and only moves on when that particular crevice is full of eggs, i.e., up to about 1,000 eggs are laid in the same place. The record of attacked trees in the plot, however, does not show that those trees near which the female has emerged are attacked to a greater extent than ones further away. Observations still remain to be made on oviposition habits of the females in natural conditions.

(iii) *Proportion of sexes*.—Reference to the above table will show that to date, out of 46 moths, 35 or 76 per cent. have been males and 11 or 24 per cent. females. This is about the normal proportion of sexes recorded from random counts of pupal skins found in this locality.

(iv) *Life cycle*.—Of the 50 moths recorded, 35 or 70 per cent. have emerged after only one year as larvæ, the remaining 15 or 30 per cent. having had a 2-year life cycle. This proportion is not surprising when the low number (about 8-9 per cent. of original attack) of larvæ which survive into their second year is taken into consideration. It is not known whether this proportion holds good in other localities.

(v) *Transfers*.—The original attack, as stated in a previous paragraph, is taken to be the number of new larvæ recorded in the first two visits to the plot in June and July. Fresh holes recorded in September and later visits are assumed to be transfers from other holes recorded as failed.

The following table shows the number of transfers in each year's attack since 1933:—

| Year.          | Original attack. | Transfers. | Total attack. | Percentage transfers. |
|----------------|------------------|------------|---------------|-----------------------|
|                |                  |            |               | Per cent.             |
| 1933 . . . . . | 551              | 115        | 666           | 17                    |
| 1934 . . . . . | 58               | 20         | 78            | 25                    |
| 1935 . . . . . | 98               | 61         | 159           | 38                    |
| 1936 . . . . . | 90               | 39         | 129           | 30                    |



It is thought that the number of transfers is somewhat greater than this, as a proportion of the new beeholes recorded at the second visit to the plot in July or August are probably transfers from holes recorded as failed. The greatest number of transfers are recorded in September and November of the first year. In January and March the number of new beeholes is very small and no transfers of second year larvæ have been recorded.

Experiments were carried out to observe the habits of larvæ when removed from the gallery and placed in the open at different periods of the year. It was found that larvæ put on the ground near teak trees did not show any positive tropism towards teak; some larvæ moved past the tree, but the majority, if they were not taken by ants, buried themselves in the ground, where they succumbed. Up to November, larvæ placed on trees rapidly found suitable places, such as old partly occluded holes and deep crevices, and covered themselves with a web within two hours, later forming a gallery in the wood. Older larvæ, similarly experimented with in January, March and during their second larval year, were very sluggish and slow and were all pulled down by ants before they could cover themselves with a web. Further research will be done during the current year.

65 per cent. of the moths which have emerged from 1934 to 1937 have been from transfers.

(vi) *Total larval population in plot.*—From the plot records the total larval population, *i.e.*, the survivors of the previous generation *plus* the current generation larvæ, was worked out for each visit paid to the plot from 1933 onwards. The highest population was found to be present in July—August each year. The highest percentage of failures from natural causes occurs between September and November and in March and April in each generation. Control measures should, therefore, be taken before September when the natural factors are not effective.

(vii) *Survival of larvæ into 2nd year.*—Available statistics from the plot records show that an average of 8.6 per cent. of the originally recorded larval population survives to pass into the second year, and from these, an average of 13.3 per cent. emerge as moths at the end of the year.

(viii) *Effect of aspect on beehole incidence.*—The average number of beeholes per tree, was, as last year, slightly greater on the southern than on the northern aspect.

(ix) *Variation of beehole incidence with size of trees.*—As in previous years, the larger girth classes were attacked to a greater

extent than the smaller ones; the following table shows the distribution of attack, and percentage of trees in each class which were attacked:—

| Girth Class.                 | 1' 1"—<br>1' 6". | 1' 7"—<br>2' 0". | 2' 1"—<br>2' 6". | 2' 7"—<br>3' 0". | 3' 1"—<br>3' 6". |
|------------------------------|------------------|------------------|------------------|------------------|------------------|
| (1)                          | (2)              | (3)              | (4)              | (5)              | (6)              |
| No. of trees . . . .         | 28               | 82               | 56               | 36               | 5                |
| Percentage of trees attacked | 18%              | 25%              | 64%              | 52%              | 60%              |
| Incidence per tree . . .     | 0.25             | 0.41             | 0.62             | 0.62             | 1.0              |

In the whole plot 94 trees out of 241 or 39 per cent. were attacked.

(x) *Effect of undergrowth on beehole incidence.*—The experimental treatment mentioned in last year's annual report was carried on during the year, but it is too early yet to analyse results.

A thinning will be carried out in the plot during the coming year; trees will be felled at various times to see if living larvae in the thinned stems vacate these for nearby standing trees and to see if moths emerge from trees felled before the normal feeding period is over.

As Dr. Beeson points out, from the evidence available it is likely that a universal factor such as weather or a local factor such as female moth emergence, has a greater effect on annual incidence than locality factors such as girth of trees, aspect, undergrowth, etc.

#### Cages—

(i) *Thogale*.—A large number of larvae were introduced into the Thogale cage at each visit to the plot, but nearly all were destroyed by ants and termites. Efforts are being made this year to keep these out, as, apart from showing that they can be capable controlling agents, they prevent life history experiments being carried out in the controlled conditions which the caged trees are meant to supply.

(ii) *Zibingyi*.—126 larvae were introduced into the Zibingyi caged trees in August. No moths emerged, and only 15 survive to date to pass into their second year. A new cage was built at Zibingyi around three teak trees, at the end of the year.

(iii) *Maymyo*.—All the teak trees in the Maymyo cage, being by now riddled with beeholes, were removed, and new stumps were planted in April 1937.

*Moth emergence, 1937—*

(i) *Thogale*.—The Field and Insectary Assistant, Forest Ranger Saw Hla Ogh, was at Thogale, South Toungoo division, throughout the moth emergence period in March 1937. The first record of emergence was on 9th March, and the last 31st March; the assistant left on 2nd April, there still being 17 holes from which emergence was expected. These were inspected daily by a local subordinate and no further emergence was reported.

Twelve female moths and seventeen males were taken, and in addition 2 female and 10 male pupal skins were found making a total of 41 moths known to have emerged, 34 per cent. being females. The area of plantations worked over was 200 acres, and it is probable that the actual moth emergence was considerably larger than this; moths emerging high up in the trees cannot be detected from the ground.

The captured female moths were put into the cage, and, after mating, eggs were collected in tubes for experiments in Rangoon. One thousand tubes, each containing 20-50 eggs were collected, and sent, the morning after laying, to Rangoon.

The egg period at Thogale was again tested and found to be 14-16 days.

Meteorological readings were again taken in the plantations, the highest recorded temperature being 98° F. on the 20th, 23rd-25th March, and the lowest being 57° F. on 9th March. The average maximum shade temperature was 95° F. and the minimum 63° F.

(ii) *Zibingyi*.—At Zibingyi, 1,800 feet above sea level, 22 miles from Maymyo, there is abundant teak of poor quality growing in the unclassified forests. In February it was evident from the emergence holes found, that there was going to be a considerable moth emergence, and this proved to be so. The following table shows the emergence record in detail:—

| FEMALES.         |                    |        | MALES.           |                    |                       |        | Total emergence. |
|------------------|--------------------|--------|------------------|--------------------|-----------------------|--------|------------------|
| Moths collected. | Pupal skins found. | Total. | Moths collected. | Pupal skins found. | Moths taken at night. | Total. |                  |
| 41               | 18                 | 59     | 30               | 10                 | 120                   | 166    | 225              |

Of this total 26 per cent. were females. It is probable that a number of emergences were missed, especially those up in the crowns of the trees.

The locality from which this very large moth emergence took place was an area of about 1 square mile containing scattered groups of natural teak 40-100 years old mostly on old cultivation and inside the village itself. From one small group of trees in the village 12 moths emerged, no fewer than 5 coming from the same tree.

The emergence period lasted three weeks; the first moth emerged on 24th March, the peak of emergence was from 30th March to 9th April, when an average of 3 female moths were taken per day. The greatest number of females to emerge in a single day was 5 on April 7th. The emergence period virtually ended on April 14th, though a single male emerged on April 20th.

Holes from which emergence was foreseen were covered with wicker baskets, and these were inspected daily. Females which emerged were put into a small wire-mesh cage in the bungalow. Males were usually attracted the same night and mating was achieved. The number of males attracted was in proportion to the number of unmated females in the cage; on April 3rd when there were 6 unmated females in the cage, 34 wild males were attracted between 8 P.M. and 3 A.M. Males usually came between 11 P.M. and 1 A.M., and normally three or four arrived together. They were captured and put into the cage containing the females, and if put directly below the female mating was achieved without difficulty. If merely introduced into the cage and allowed to fly about on their own, they were very apt to batter themselves to pieces without finding the female, the location of which appeared to necessitate the flying of males in unarrowing circles, which they were unable to do in the cage. The same habits were observed in the large outdoor cages.

The following night fertilised females were transferred to cylindrical wire-mesh cages about 1 foot high by six inches diameter, and laid eggs readily, thrusting the ovipositor through the mesh into tubes filled with crumpled paper held in readiness. 1,800 tubes of eggs were collected, of which half were sent to Rangoon for laboratory experiments and half were used for local experiments; a summary of these is given in a later paragraph.

The egg period at Zibingyi was 12-14 days, compared with 14-16 days at Thogale, 11 days in Rangoon and 20-22 days in Maymyo.

Meteorological records were kept; a maximum and minimum thermometer was hung on a tree and shaded from the direct sunlight. The highest temperature recorded was 107° F. on April

5th and the lowest 61° F. on 13th and 17th April. The average maximum temperature between 30th March and 30th April was 97.7° F. and the average minimum between the same dates was 66.8° F.

No explanation can be found for the unprecedented moth emergence at Zibingyi this year and the extremely local nature of its incidence. Though hundreds of trees were searched, less than 10 moths were found to have emerged outside the groups of trees in the village and its immediate surroundings, which yielded all the moths recorded in the table. Analysis which it is hoped to carry out in the coming year may give a clue to the reasons for this.

*Experiments with eggs and larvæ in Rangoon and in Zibingyi.*—With the permission of the authorities of Rangoon University, Dr. F. J. Meggitt, of the Department of Biology, again undertook to carry out experiments with the eggs and early larval stages of *ceramica*, testing lethal condition. In the course of them he dealt with nearly 3,000 tubes of eggs collected in the field, and our thanks are due to him and to the Biology Department for this work, which entails constant supervision, and the results of which are complex.

Both Dr. F. J. Meggitt, in Rangoon, and the writer (Mr. P. F. Garthwaite) in Zibingyi, carried out experiments with the early stages, exposing eggs and young larvæ in conditions as nearly natural as possible, for varying lengths of time, in various situations, direct sunlight, shade, compass points on trees, etc. The permutations and combinations of such experiments are manifold. The experiments were carried out after the close of the year and will be dealt with in a subsequent report; valuable information was obtained, which gave pointers to the direction of further research in this field which it is proposed to carry out during the 1938 moth emergence period.

*Alternative hosts of Xyleutes ceramica.*—Of great interest is the following report from the Divisional Forest Officer, Insein (Mr. D. J. Atkinson):—

“ I mentioned that years ago I had once taken what I thought, but was then unable to prove, was a beehole larva in *yemane* (*Gmelina arborea*) at Namtu. By a most curious coincidence I yesterday confirmed this doubtful record, by taking 4 pupal skins, a specimen of removal by woodpecker, and a living pupa, all ex-10 years old *yemane* (*Gmelina arborea*) in a 1927 plantation at Myaungtaga, South Hlaing

Yoma reserve. I, send you the wood specimen, a good museum piece, and the 4 pupal skins herewith—the living pupa I have *in situ*, and hope the moth will emerge in a day or so.

Note the early emergence—a day or so before 22nd February—you will see in Beeson's Records a note of mine recording pupæ in Insein in February, but not moths."

The fact that *ceramica* is able to complete its life history in *Gmelina arborea* and also the early emergence period in Insein are important observations. There is now evidence that the emergence period varies with latitude—it is later in the north than the south, though there is annual variation in each locality. It may be that the growing season ends earlier in the south and hence pupation is earlier, but it is probably due to a variety of ecological factors, such as temperature, leaf-fall, cessation of flow of sap, etc.

Day old *ceramica* larvæ were introduced into *Gmelina arborea* in Maymyo and to date (June 1937) are flourishing in this host.

#### (b) Analysis of Past Attacks.

No analysis was done during the year. Data from previous analysis were re-examined with reference to special points, such as the effect of thinning history on annual incidence, correlation between the number of beeholes showing on the surface of a log and the total number in the log, correlation between annual incidence and moth emergence, and the comparison of the relationship between failed beeholes and moths for light and heavily beeholed localities to estimate the period when natural checks fail in the latter.

It is proposed to carry out beehole analysis by hand in a number of localities in the coming year with a view to settling certain definite problems which were brought out by earlier analysis.

#### (c) Natural Enemies.

The *Ichneumonid* parasite of *Xyleutes ceramics* has now been described and named *Nemeritis tectonæ* J. F. Perk. Two living cocoons were found in beeholes at Thogale, South Toungoo division, on 28th June, and were brought back to Maymyo where a female emerged on 17th July. This specimen lived for 38 days in the insectary but no male was obtained for it. Another living

cocoon was found at Thogale on 12th August, but no emergence took place.

It was mentioned in a previous paragraph that natural control is not effective to reduce the numbers in each generation before September. *Nemeritis* parasitises *ceramica* in June and July, just at a time when additional checks are wanted. The introduction and, if possible, colonisation of this parasite in large numbers would be of great benefit, and preliminary research into the insectary breeding of the parasite is to be undertaken during the coming year. The difficult problem is to obtain living parasites with which to start the first generation.

That ants can be efficient controlling agents of the egg and larval stages of *ceramica* was observed on many occasions. Of 20 larvæ freed on trees for studying transfer habits, 14 were pulled down and killed by ants before they had entered the tree. In the Zibingyi cage, a mass of about 1,000 eggs laid rather openly on the bark of one of the trees were all removed by ants within four days; the work of the ants being observed.

Termites too, in plantations, play their part as controlling agents; this year, particularly, in the Thogale cage, although 250 larvæ were introduced into the trees, only 5 survived at the close of the year, due partly to ants and partly to termites, whose earth walls covered the trees and blocked up the beeholes, killing the inmates. In the observation plot it has been noted that trees which have been covered with termites' walling in the previous rains, rarely get attacked by *ceramica* the following year, the smooth bark surface left after the earth has fallen away being unfavourable both for oviposition and for the young larvæ.

A survey of the species of ants and termites important in this respect will be made during the coming year.

## II.—Defoliators.

No field work was done on the defoliators during most of the year, which was taken up by getting all the parasites bred out from *Hapalia macharalis* and *Hyblaea pueria* during the last five years expertly identified, and the results of the five years research written up. Most of the parasites were identified at Dehra Dun, and a comparison of the lists of species bred out of Burma and Madras material showed that an interchange of living parasites between the two countries, with a view to establishing introduced species, would be likely to prove beneficial.

Mr. M. H. Desai, Insectary Assistant, with a staff of two setters, was, therefore, transferred to Insein in March 1937 and a parasite breeding insectary was set up there, housed, through the kind offices of the Veterinary Department, in a large laboratory room in the Veterinary Research Institute, to export Burma parasites to a similar Insectary run by the Forest Research Institute at Nilambur, Madras, and to carry out mass breeding and liberation of parasites sent from there. A stock of *Cedria paradoxa*, a Braconid parasite of *Hapalia macharalis* which does not occur in Burma was safely received from Nilambur, having been sent by ship in cold storage in the adult stage, and at the time of writing breeding is going on successfully and several colonies have been liberated.

The work will continue throughout the year.

### III.—Other Pests of Teak.

*Phassus* sp. (Lepidoptera, Hepialidæ).—Billets of *yemune* (*Gmelina arborea*) containing mature larvæ were collected in the Nanhlaing Reserve, Shwebo, at the beginning of September, and 11 male and 17 female moths emerged between the 24th September and the 19th October. In every case the trees attacked were associated with the creeper *Buettneria pilosa* from which attack had evidently originated.

No mating of the moths bred out was achieved. The adults are very delicate, and in captivity they died within two days, usually in a battered condition; some infertile eggs were laid.

The study of this insect will be continued in the coming year.

### B.—PESTS OF OTHER SPECIES OF ECONOMIC IMPORTANCE.

*Pyinkado* (*Xylia dolabriformis*) borers.—As indicated in last year's report a preliminary survey of the distribution of the longicorn borers of *pyinkado* was carried out, and specimens were collected from Ataran, Insein, Zigon, Thaton, Pynmana, Tharrawaddy and Myitkyina divisions.

Ataran division was visited in May, and trees were cut up and analysed to trace current and former attacks in the Miok and Dawebauk Reserves and in the unclassified forests in these localities. In the Miok Reserve two trees of over 3 feet girth were analysed, and in each tree three galleries of a large Cerambycid, afterwards identified from bred specimens as *Pachydissus* sp. were found. In the Dawebauk unclassified forests three trees were analysed, and found to contain 5, 4 and 8 galleries



of *Pachydissus*, eleven of these being of the current year. Many large trees in the Reserve were carefully examined, but no signs of current attack were seen. This corroborates the evidence of the Moulmein mills, which were also visited, that timber from unclassified forests is attacked to a greater extent than that from reserves in this Division. *Pachydissus* attacks the large living tree over 2 feet 6 inches in girth and no galleries were found above 40 feet from the ground. The mature gallery is a large one, running radially for three or four inches and then axially for five or six inches, and galleries up to two inches in diameter were found.

Billets containing living larvæ were caged in Maymyo and so far three adults have emerged at the end of April 1937 implying a life cycle of two years, as the larvæ were well grown when the specimens were collected in May 1936.

Plantation trees in Ataran and Thaton were found to be attacked by the lamiid *Aristobia approximator* Th., which, however, confines its attacks to trees under 10 years old, and which therefore only damages the heart of the tree.

Many specimens of *Dialeges undulatus* Gahan, *Ceresium leucosticticum* White and *Noserius tibialis* Pasc. were bred out of billets from Ataran and Myitkyina. These are normally borers of felled or moribund trees, and the large number of emergences were probably due to breeding inside the cages.

*Pachydissus* is capable of the greatest amount of damage, and it was presumably the galleries of this species which caused the rejection of sleepers referred to in last year's report; but the preliminary survey in forests reputed to show greatest attack does not lead to the conclusion that damage is severe, nor did inspection of the mills reveal any serious loss in conversion due to insect attack. If millers realise that "wormy" railway sleepers will not be passed, it should be possible for them to eliminate attacked portions during conversion without any great loss.

*Calopepla leayana* Latr.—The *Gmelina arborea* plantations at Namtu, Northern Shan States, have now been abandoned, and no further work was done by this branch on the insect. The Divisional Forest Officer reports a moderate attack in a year characterised by heavy rainfall.

*Lyctus and allied beetles*.—The survey of the distribution, biology and importance in Burma of the hostrychid beetles was continued, and is not yet complete. *Minthea rugicollis* Walk is the commonest species bred out of material so far collected.

*Ochrophara montana* (Pentatomidæ).—The flowering of *kyathaung* bamboo (*Bambusa polymorpha*) gregariously over large tracts of forest in the Pegu Yomas, led to an enormous population of this bug, which feeds on the seeds of the bamboo. It was so numerous, in some localities, particularly in Yamethin division, that the forest floor and lower undergrowth was covered with a mass of these insects over whole acres at a stretch. Most numerous in June they appeared to have died out by the end of the rains.

*Xylentes persona* Leg.—A number of ornamental *Cassia fistula* and *Cassia renigera* trees in Maymyo and Rangoon were found to be attacked by this insect and records were kept. From one *Cassia renigera* tree in Rangoon 106 pupal cases were taken in March, implying a considerable recent moth emergence; but fresh pupal skins have been found during most months of the year. This is consistent with the variable length of larval life (18 months to 2½ years) recorded for specimens in caged trees and with the fact of finding larvæ of several distinctly different sizes at the same time in the same tree.

*Tung* (*Aleurites fordii* and *Aleurites montana*) seedlings in nurseries in the Shan States were reported to suffer to a certain extent from attack by crickets (*Brachytrypes* sp.) and by the weevil *Astychnus lateralis* F. Poison baits were recommended for dealing with the former.

*Cedrela toona* in the Southern Shan States was reported to be so severely attacked by the toon shoot borer (*Hypsipyla robusta*) that 126 acres of plantations had to be written off.

#### C.—GENERAL INSECTARY WORK.

179 cages were in use at the close of the year, mainly for the breeding of wood boring insects. 2,133 insects emerged and 1,495 were set.

Great progress was made by Mr. J. J. Vernal, during the writer's absence on leave, in writing up breeding cage records and in sending insects to experts for identification. Most of the insects were sent to Dehra Dun where they were dealt with by the Systematic Entomologist and by the Forest Entomologist to whom our thanks are due for the work done in this connection.

The main groups dealt with were the parasites of the teak defoliators and the *Cerambycidæ* and *Bostrychidæ*.

## D.—PROGRAMME.

Dr. C. F. C. Beeson, Forest Entomologist, Dehra Dun, paid a visit, unfortunately curtailed, to Burma in February 1937, and outlined a programme of research, which was accepted at a conference presided over by the Chief Conservator of Forests, in Rangoon, before he left.

## CENTRAL PROVINCES.

## I.—ENTOMOLOGY.

In Supkhar, Balghat, a sal defoliator *Pæctes (Ingura) subapicalis* Wlk. was noticed in epidemic form and specimens are to be sent to Dehra Dun for studying the life cycle of the pest.

Samples of match boxes damaged by a powder-pest beetle were sent by the Laxmi Match Factory to the Divisional Forest Officer, Bilaspur, who forwarded them to the Forest Research Institute, Dehra Dun. The beetles responsible for the damage were identified as *Lyctus africanus* and *Heterobostrychus aequalis*. The Forest Entomologist advised the factory regarding remedial measures.

The attack by the teak defoliators *Hyblæa puera* and *Hapalia machæralis* was very severe this year especially in Mandla, Yeotmal and Nagpur, which resulted in a very poor seedling. As the prevalence of these pests appears to be increasing in the province, and as the indirect financial loss caused by them is estimated to be very considerable, the results of experiments at Nilambur, where some insects which live parasitically on the caterpillars of these defoliators are being introduced from Burma, are of interest to this province. If successful, similar experiments are to be started in a secluded and closely confined area of the provinces.

## II.—ZOOLOGY.

A general increase in the number of does and hinds especially in sanctuaries is reported from most divisions and also in the amount of damage these animals do to forest seedlings by browsing.

## NORTH-WEST FRONTIER PROVINCE.

## INSECT PESTS.

*On blue pine.*—For some years past stray saplings of blue pine have been dying near Naddi in the Lower Kagan range. The cause of death has now been determined by the Forest Entomologist as a weevil, *Hylobius angustus*, the larva of which attacks

the stem at soil level and girdles it under the bark. The Forest Entomologist reports that this insect characteristically attacks plants which are bent at the base by snow pressure or soil creep, as well as those injured at the base by rolling boulders or fallen trees. There appears no danger of the attack reaching serious dimensions and stray casualties will have to be accepted as a matter of course. Attacked stems should be removed and the weevils destroyed.

*On chir.*—Grasshoppers did considerable damage to newly germinated chir seedlings on sown patches in the Batrassi regeneration area. The damage was partially checked by means of Paris green and lead arsenate.

Considerable damage was caused over about 1,000 acres of chir forest (mostly guzara) in the Lower Siran range by a defoliating caterpillar which has yet to be identified. Such attacks are rare on chir, though the local people say the same area was affected about twenty years ago.

## CHAPTER V.

### UTILIZATION AND ECONOMIC RESEARCH.

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#### ASSAM.

##### I.—GENERAL WORK OF ADMINISTRATION.

Mr. S. M. Deb held charge of the post of Forest Utilisation Officer during the year under review.

##### II.—EXPERIMENTAL ACTIVITIES.

###### (1) *Wood technology.*

(a) *Semul* (*Bombax malabaricum*).—There is a popular belief, based on the two distinct colours, viz., “yellowish-brown” and “white” in which the wood occurs, that there are two varieties of *semul* in the Brahmaputra Valley.

Results of the study of various specimens indicate that the yellowish-brown wood is generally derived from trees stunted, slow in growth and growing on such hill slopes and grass lands as are exposed to frequent and fierce fires, whereas trees growing in suitable places and of faster growth yield the white timber which is coarser-grained and softer.

(b) *Collection of authentic wood specimens for anatomical study at the Forest Research Institute, Dehra Dun.*—Specimens of 183 species are wanted of which about one-third have been supplied and collection of the rest is in rapid progress.

###### (2) *Timber seasoning.*

Our activities to improve the quality of indigenous timber by checking degrade that develops in unseasoned wood and thus to increase the demands, by remedying, as far as practicable, the general complaint of users in regard to the scarcity of seasoned stuff, have aroused the interest of timber-dealers who, except those of little capital, have erected seasoning sheds. It appears that it will be some time before the doctrines of clean timber yards and depôts and of the stacking of materials for air seasoning are rightly served.

(3) *Timber testing.*

Many consumers seem to possess some empirical knowledge about the differences in strength and durability of our sal from various localities, which influence variation in prices. It was therefore thought essential to support a proposal for the strength and durability tests of sal to be carried out by the Forest Research Institute, and a resolution to this effect was passed at the Utilisation Conference held at Dehra Dun in March 1937.

(4) *Wood preservation.*

Necessity for a suitable preservative for inferior woods and bamboos is being realized, and Ascu would have been highly appreciated had it been made locally available at prices compatible with the purchasing capacity of the prospective users of treated materials.

A comprehensive statement giving the information required under paragraph 32 of the Raman Committee Report was prepared and submitted for transmission to the Railway Board. Forty-five merchantable timber species were dealt with.

(5) *Woodworking.*

(i) The following species were supplied to the Gramophone Company of Dum-Dum, Calcutta, for cabinet-making tests:—

*Toon* (*Cedrela toona*).

*Paroli* (*Stercospermum chelonoides*).

*Gunseroi* (*Cinnamomum glanduliferum*).

*Gondhelipoma* (*Dysoxylum hamiltonii*).

*Sam* (*Artocarpus chaplasha*).

*Ping* (*Cynometra polyandra*).

*Kurta* (*Palaquium pollyanthum*).

*Mahi-thekera* (*Carallia integerrima*).

Including twelve of last year, the quantity of samples sent comes to twenty species. The following is an extract from the report from the Cabinet Factory Superintendent of the Company:—

"... we have now selected two species of timber from the samples sent to us which we anticipate will be suitable for small Gramophone cabinets, *bonsum* and *titachump*."

(ii) *Shuttles*.—No report has yet been received on the samples of *ajhar* (*Lagerstræmia flos-reginæ*) and *bonsum* (*Phæbe goalparensis*) sent last year to Bombay. A local cottage industrialist is using the latter wood with success for the manufacture of shuttles for hand looms.

(iii) *Bobbins*.—Samples of *sam* (*Artocarpus chaplasha*), *haldu* (*Adina cordifolia*), *rhokan* (*Duabanga sonneratioides*), *bola* (*Morus lævigata*) *ajhar* (*Lagerstræmia flos-reginæ*) and *bonsum* (*Phæbe goalparensis*) were sent to a firm in Calcutta for test. No report is yet to hand.

(iv) *Umbrella handles*.—Of five samples of timber supplied to the Bharat Industries Corporation, Howrah, the following three were found satisfactory:—

*Bonsum* (*Phæbe goalparensis*).

*Titachapa* (*Michelia champaca*).

*Gogra* (*Schima wallichii*).

(v) *Tool handles*.—A log of *ping* (*Cynometra polyandra*) has been sent to the Indian Turpentine and Rosin Company's Factory at Clutterbuckganj, Bareilly, for tests for industrial purposes.

(vi) *Seating accommodation for the Assam Legislative Chamber*.—*Amari* (*Amoora wallichii*) for legs has been successfully used by the supplying firm, the Don Bosco Industrial School of Shillong, and birch wood (*Betula alnoides*) for other parts of seats and desks.

(vii) "*Chesses*" for the use of *Sappers and Miners units*.—The Superintendent, Gun Carriage Factory, Jubbulpore, was supplied, on payment, through a contractor, with his requirement for a small quantity of *bonsum* (*Phæbe goalparensis*) passed by the Utilisation Branch.

#### (6) *Match wood*.

Samples of eleven species consisting of those mentioned in the last year's report and of *Hymenodictyon excelsum* and *Polyalthia simiarum* were sent for investigation to the Assam Match Company's Factory at Dhubri, which has not yet been able to carry out the test owing to a labour strike.

#### (7) *Woods for packing cases*.

A firm of Newcastle, Australia, wanted a light white odourless timber that will not taint butter and will stand up to nailing for butter boxes. *Bhelu* (*Tetrameles nudiflora*) was suggested to

them who were also put in touch with the Surma Valley Saw Mills with necessary instructions to the latter for the supply of a sample consignment, which is reported to have been despatched very recently.

Samples of the following woods were sent to the Venesta Factory, Kamarhati, with a view to investigating the possibility of manufacturing tea chest battens:—

*Hollong* (*Dipterocarpus macrocarpus*).

*Simul* (*Bombax malabaricum*).

*Bhelu* (*Tetrameles nudiflora*).

*Hollong* battens are used for the same purpose by the Assam Railways and Trading Company's Veneer Mills at Margherita with success, and the fact was intimated to the Manager of the Venesta Factory. But it is interesting to note the influence of tradition, as has been made clear in a letter from him which is reproduced below:—

“ We are in receipt of your letter of the 16th instant, together with the sample tea chest battens for which we thank you.

Since we took up this matter with you we have been given to understand by our London office that it is feared our tea chest customers having for so long been accustomed to the use of a white pine batten, would look with disfavour and perhaps suspicion on any other kind of wood that did not have the same white appearance.

The samples you have submitted to us fall considerably below this standard so we are afraid they will not suit our purpose, particularly the *hollong* which is quite red.

We shall be glad to hear whether you are able to supply any other kind of timbers more in line with our existing pine batten, a sample of which we have already sent you.”

#### (8) *Plywood and veneers.*

A list showing the varieties of timber suitable either for commercial white plywood or decorative veneer wood with approximate cost per ton at Calcutta, was prepared and submitted to the Forest Economist, Dehra Dun. Eleven species were suggested for white plywood for boxes, containers and utility work and for cores for laminated stock, and seven for decorative plywood and ornamental veneers, laminated panels, furniture, etc.



(9) *Paper pulp.*(a) *Bamboo.*

A preliminary enquiry shows that more than twenty-five varieties of bamboo occur in the Province in large quantities, of which there are only four species that are at present important from the point of view of pulp industry. They are arranged below in descending order of merit as regards the extent of occurrence, annual yield and accessibility:—

*Muli* or *tarai* (*Melocanna bambusoides*).

*Pecha* or *rako* (*Dendrocalamus hamiltonii*).

*Khang* (*Dendrocalamus longispathus*).

*Mirtenga* (*Bambusa tulda*).

The current demand for these materials for the manufacture of paper pulp does not represent even one hundredth part of the output.

(b) *Grass.*

Some species of grass growing in abundance have been found suitable for pulp-making in the laboratory test at Dehra Dun. They are awaiting industrial investigation.

(c) *Wood.*

For mechanical pulp, cheap wood of little value for other utility purposes, may be advantageously tried. Probable timbers found in commercial quantities are:—

*Bombar malabaricum* (of inferior quality).

*Gmelina arborca* (of inferior quality).

*Kydia calycina*.

*Macaranga* spp.

*Sterculia* spp.

*Tetrameles nudiflora*.

It is gratifying to mention here that appropriate resolutions were passed at the Utilisation Conference held in March 1937, at Dehra Dun, to the effect that the Paper Pulp Section of the Forest Research Institute would carry out investigations necessary for the development of the paper pulp industry, with a view to improving the utilisation of these raw materials.

(10) *Minor forest produce.*

*Sati (Curcuma angustifolia).*—Botanical specimens were supplied to the Forest Research Institute, Dehra Dun, for identification of the species yielding flour (*tikur*) from roots.

*Chaulmugra (Hydnocarpus kurzii).*—Further orders were received from the Acting Chief, Direcção Dos Services De Agricultura, Colonia De Mogambique, for supplying fresh seeds for test.

*Phagdimia (Trema politoria).*—In continuation of what was stated last year a second sample consisting of uncrushed fibrous bark was supplied to the Assam Oil Company and the following extract from the report on the test of the same, received from the Manager, may be of interest:—

“ . . . . . Our Field Chemist writes as follows:—

In the laboratory *Trema politoria* gave good results in the mud treatment. It proved difficult, however, to prepare it in the form most useful for the work it was intended for, *i.e.*, in fibres 1" long. This difficulty has not yet been overcome and we should welcome any suggestions you may wish to make in this connection. We should be glad to learn the approximate cost of the prepared, uncrushed bark.”

*Pishuchban (Eupatorium odoratum).*—Flower and stem specimens were sent to Dehra Dun for essential oil test and the Biochemist writes as follows:—

“ The flowers and stems of *Eupatorium odoratum* arrived here in very dried condition and gave on distillation, only traces of the essential oil. It appears that the oil has been lost during transit and drying. I shall be obliged if you will kindly send, when available, freshly plucked flowers only (3-5 mds.), and slightly air dried before despatch, to prevent their decomposition during transit.”

*Bakhal bih (Derris species).*—Samples of *Derris* root were sent for valuation to two firms in England and Messrs. Cooper McDougall & Robertson, Ltd., of Berkhamsted, report as under:—

“ We thank you for your letter of the 30th April, and for the samples of *Derris* root which you forwarded to us.

We find on analysis that the sample is very low in ether extract and of little commercial value, although it contains a good proportion of rotenone in comparison with the ether extract.

Good grades of commercial *Derris* may contain up to 25 per cent. of extract and 10 per cent. rotenone, and in view of the fact that the sample you forwarded contained less than 5 per cent.

extract it would not be a commercial proposition for us to consider the importation of this material."

Since receipt of this report, doubt has arisen as to the identity of our *Derris* and the Botanical Officer has been requested to examine further.

*Bakhal bih (Millettia pachycarpa)*.—Samples of root were sent to Dehra Dun with request for preliminary test and the following report from the Forest Economist is interesting:—

"The sample of roots of *Millettia pachycarpa* sent along with your above quoted letter has been analysed by the Bio-chemist with the following results:—

|                                     | Per cent. |
|-------------------------------------|-----------|
| Moisture in air dry roots . . . . . | 11.9      |
| Crystalline substance . . . . .     | 0.75      |
| Resinous substance . . . . .        | 1.69      |
|                                     | <hr/>     |
| Total ether extract . . . . .       | 2.44      |
|                                     | <hr/>     |

The crystalline substance (melting point 163°-164°) has been identified as rotenone, the active insecticidal principle of *Derris*. The above result is interesting and at the same time important, as it adds one more species of plant, of Indian origin, to the list of only a few species of plants in the world, which contains this important insecticidal principle.

The rotenone content of plants varies with the locality and age of the plant. This has been noticed in the case of *Derris elliptica* growing in Assam. It is, therefore, desirable that roots of *Millettia pachycarpa* growing in different localities in Assam and collected from plants of different age (below 18 months, 18-24 months and above 24 months) should be examined for their rotenone content, and I should be thankful if you would arrange to send me the above mentioned samples for further examination by the Bio-chemist. About 5 lbs. each of completely air-dried roots will be sufficient . . . . ."

*Leaves for wreath-making*.—Specimens of leaves from the following species were supplied to the British Legion Poppy Factory, Surrey:—

- Mesua ferrea*.
- Michelia champaca*.
- Michelia phelocarpa*.
- Pachylarnax phelocarpa*.
- Ficus* spp.

The Works Manager of the firm has kindly agreed to treat them and to send a report in due course.

*Gandhi (Homalomena rubescens)*.—In continuation of what was stated last year the following extract from a letter from the Department of Pharmacology, School of Tropical Medicine, Calcutta, will be of interest:—

“ An essential oil has been isolated from *Homalomena rubescens* roots and it is being worked up. The amount of the oil obtained from the roots, however, is rather small and we shall be greatly obliged if you could send about 20 seers more of the roots to complete the investigation.”

Twenty seers of roots were supplied before the close of the year.

*Ahoi (Vitex peduncularis)*.—In continuation of last year's statement, the report from the School of Tropical Medicine, Calcutta, is quoted below:—

“ *Vitex peduncularis* was analysed and did not show the presence of any active principle. Small traces of an alkaloid were found; the quantity, however, was so small that further investigations were not possible. It has also been tried clinically at our school but not found to be useful in Malaria. If, however, you could send us about 20 seers of quite young leaves, dried in shade, we shall be glad to investigate it further.”

Twenty seers of young leaves were in process of collection at the end of the year.

*Sia nahor (Kayea assamica)*.—Twenty seers of entire fruits of *sia nahor* were sent to the Forest Economist, Dehra Dun for preliminary examination by the Bio-chemist.

*Leluk (Beilschmiedia roxburghiana)*.—Forty lbs. of bark were sent to Dehra Dun for analysis by the Bio-chemist. The hill tribes of the North-East Frontier tracts attribute to this bark properties for healing chest and lung troubles.

*India rubber (Ficus elastica)*.—Mixed with Para rubber it makes a good article of commerce. In the process of sheet-making it appears to be more expensive than other varieties of rubber in the market. It has successfully stood the manufacturing trials made by the Premier Rubber Works, Ltd., at their factory at Narikeldanga, Calcutta.

*Gutta percha (Palaquium polyanthum)*.—Fifteen seers of latex were collected by tapping some trees and samples distributed to several prospective dealers. In this connection, a letter from

Messrs. India Rubber Gutta Percha and Telegraph Works Co., Ltd., Calcutta, is quoted below:—

“ Thank you for the parcel containing 2 lbs. of raw *gutta-percha*. I propose forwarding this sample to our works in England, but should be obliged if you would please advise what quantities are available and the approximate price delivered Calcutta.

We notice that this *gutta-percha* has already undergone some primary cleansing process, and as our supplies from West Africa are of a much rougher and dirtier type the prices of the two types would be appreciated, as in the cleansing and pressing process all dirt can be eliminated without extra cost.”

They have been supplied with the information asked for, except that no definite statement has been made in regard to prices of which we have little knowledge at the moment. They have been requested to quote what they could offer. From subsequent correspondence it is understood that the Manager has sent the sample to their London Office for valuation.

An explanation as to the “ cleansing process ” mentioned in the above quoted letter may be of interest. No attempt was made to clean the stuff. The latex when collected fresh was in thin liquid condition free from superficial dirt, and after some days the watery portion became normally separated leaving a very soft plastic residue to settle at the bottom of the container. It is from this residue that the sample was sent.

### III.—COMMERCIAL ACTIVITIES.

#### (1) *Timber Trade.*

##### (a) Supply of Timber to Railways.

##### (1) *Sleepers—*

*Nahor (Mesua ferrea).*—A complaint has of late been received in regard to the scarcity of good quality sleepers of *nahor*, which has long satisfied the requirement of the Dibru-Sadiya Railway. This question is under investigation.

##### (2) *Timbers other than sleepers—*

*Purchasers' Agency.*—Twenty-five tons of sissoo (*Dalbergia sissoo*) in logs, and about four hundred tons of converted material mostly from *bonsum (Phæbe goalparensis)*, *amari (Amoora wallichii)* and *titachapa (Michelia champaca)* were supplied to the Assam Bengal Railway, and about fifty tons of mixed woods to the Tezpur Balipara Railway.

## (b) General.

*Internal consumption.*—Use of woods including plywood tea chests by the two local veneer mills is steadily increasing.

*Export.*—There was no lack of animation in the export trade as well.—Export amounted to about thirty thousand tons of woods consisting mainly of:—

Sal (*Shorea robusta*).

Sam (*Artocarpus chaplasha*).

Ajhar (*Lagerstrœmia flos-regina*).

Amari (*Amoora wallichii*).

Bonsum (*Phœbe goalparensis*).

Gurjan (*Dipterocarpus pilosus*).

Titachapa (*Michelia champaca*).

Gogra (*Schima wallichii*).

Simul (*Bombax malabaricum*).

Bhelu (*Tetrameles nudiflora*).

## (2) Trade in minor forest products.

*Bamboos.*—Consumption by the Indian Paper Pulp Company has not increased but the demand from the adjacent districts of Bengal for domestic use, indicates slight improvement. The umbrella handle industry seems to have recovered from the setback caused by the general trade depression.

*Grass.*—Because of the extensive use of corrugated iron sheets, the demand for thatching grass has decreased especially in Upper Assam. In the Surma Valley and Lower Assam there is still a good market for it.

*Lac.*—The growers are not getting the true value for their crop owing to the intervention of middlemen in the trade.

*Cane.*—The market was steady.

*Rubber (Ficus elastica).*—A *mahal* was created for the whole of the Province and farmed to the Premier Rubber Works, Ltd., for 3 years for a monopoly fee of Rs. 700 in addition to an *ad valorem* duty of 12½ per cent. to be paid on the materials collected.

*Pipul (Piper longum).*—The market had a steadier tone.

*Honey.*—Price changes moved to higher levels.

*Bee's wax*.—Market was active with prices indicating tendencies to move in buyers' favour.

*Herbal drugs*.—There was an animated market for *aktachita* (*Plumbago rosea*), but the supply was very poor. A new addition was *Polypodium* fern which is used by an apothecary of Manipur State for a proprietary preparation.

*Chaulmugra* seeds (*Hydnocarpus kurzii*).—Neither the production nor the price was up to expectations.

*Agar* (*Aquilaria agallocha*).—There was a very strong market. There are many grades in which this luxury wood appears before the users. Prices for the top qualities reached the pre-slump peak levels, viz.:—

Quality I.—Rs. 500 to Rs. 600 per *maund*.

Quality II.—Rs. 300 to Rs. 400 per *maund*.

Quality III.—Rs. 100 to Rs. 250 per *maund*.

"*Dhum*" is a general term for all the inferior qualities which also have a different classification. *Dhum* sold for Rs. 20 to Rs. 80 per *maund*.

*Agar* oil sold for Re. 1-4 to Rs. 2 per *tola* (approximately 2/5 oz.).

*Elephants*.—444 animals were captured, of which 1 died and 14 were shot in stockades, 131 released, 6 given to the capturers on payment of royalty and 292 sold. Average price received was Rs. 573 per head, which was not at all unsatisfactory in view of the increasing motor traffic and inflated supply of elephants.

*Lime stone*.—Owing to the growing competition from cement the use of lime is decreasing with deterrent effect on the development of business in lime stone.

*Rhinoceros skins, horns and hoofs*.—Four horns, weighing 322 *tolas*, were sold for Rs. 3,205, or Rs. 9-15-3 per *tola*, or Rs. 398 per lb. Ten hoofs weighing 43 oz. fetched Rs. 25-2, or Rs. 9-5 per lb., and one skin weighing two *maunds* Rs. 300 or Rs. 14 per lb.

*Ivory*.—Twelve *maunds*, twenty-three *seers* and twelve *chittacks* of found and confiscated elephant tusks were sold by auction for Rs. 5,368 or Rs. 10-10-6 per *seer*.

### (3) *Railway and steamer freight.*

*Elephants*.—As a result of further discussion with the Traffic Manager (Commercial), Assam Bengal Railway, the rates for full

grown elephants has been reduced from 12 annas a mile to 8 annas a mile with effect from December, 1936, in booking over the Assam Bengal, Eastern Bengal and Cooch Behar State Railways, which is really a substantial concession. Had it not been partly for this concession and its predecessor mentioned in last year's report, and partly to improved financial conditions, it would have been difficult to obtain such prices for elephants as were realized during the year.

*Agar (Aquiloria agallocha).*—Station to station rates for *agar-wood* including "*dhum*", which are 33 per cent. less than the usual, were introduced by the Assam Bengal Railway. This concession has afforded a great stimulus to the trade of *agar* in general and "*dhum*" in particular, with the consequential keener demand for *agar mahals*.

These reductions of freight have not only benefitted the trade in *agarwood* and elephants but also the Railways by increasing the traffic. There are many other commodities which, with sympathetic consideration from the transporting agencies, will be of immense service and good for them as well as for the producers, distributors and consumers.

A list was prepared showing the weight per cubic foot of dry and raw wood of various species of commercial timbers of Assam and submitted to the Traffic Manager (Rates, Development and Publicity), Eastern Bengal Railway.

#### (4) *Publicity and Propaganda.*

(i) For the encouragement of a wider use of timbers only little known, a consignment of *gogra* (*Schima wallichii*) scantlings was sent through a merchant firm to Bikrampur, which is a very big consuming centre for timbers and sold at low prices which were tempting to the buyers.

(ii) With a view to extending their use, attention of wood-workers in general and furniture-makers in particular was, wherever possible, directed to the actual use of *amari* (*Amoora wallichii*), *haldu* (*Adina* spp.), *hollock* (*Terminalia myriocarpa*), *boga-poma* (*Chukrasia tabularis*), *poma* (*Cedrela* spp.) and *sam* (*Artocarpus chaplasha*) in accessible places.

(iii) Arrangements were made with the Officer-in-charge, Commercial Museum and Publicity Department, Corporation of Calcutta, for exhibiting samples of our forest products in the Com-



mercial Museum and for giving proper publicity to them. To start with the following samples were supplied :—

- (1) A small bullock cart made of ivory.
- (2) Some crude Indian rubber.
- (3) Eight kinds of *agarwood*, including *dhum*.

(iv) Mention was made in the last year's report, of the improvement effected in regard to the market for sal logs at Sapotagram, the biggest sale depôt in the Province. The next important depôt is Kukurmara, where there was a glutted market for the last two years, because of the lack of transporting facilities arising from a shoal formed at the confluence of the Kulsi River with the Brahmaputra.

The course of the Kulsi River was examined from Kukurmara to the Brahmaputra River. The purchasers as well as the boatmen were advised as to the means of tiding over occasional backflows with the help of sails when wind would blow favourably, so as to enable them to extract logs cheaply. They had also been given an assurance of safety before they could be persuaded to launch upon a risky undertaking. These efforts more than fulfilled expectations.

(v) A formula for curing, cleansing and preserving the enamel of elephant tusks was adopted. It not only served these purposes well but also prevented loss in weight to a large extent as has been noticed in the case of freshly extracted tusks. The high average price of Rs. 10-10-6 per seer of ivory obtained in the last sale against Rs. 9-8-6 in the previous one, is attributable to the improvement in quality resulting from the treatment accorded to the material and also to the wide publicity of the sale.

#### (5) *Miscellaneous.*

1. *Departmental sleeper supply.*—With the object of helping the Assamese contractors of slender capital, who are in danger of being squeezed out of business, a triennial contract for the supply of 50,000 metre gauge sal sleepers per year was secured from the Eastern Group of Sleeper Control. At the very outset they showed great earnestness which took no time to decline owing to lack of the requisite funds. Necessary advice in the matter of even finance was not denied. In short the Department left no stone unturned to help them and its efforts were highly appreciated in the press (*vide* the *Biweekly Assamiya*, dated the

31st March 1936). But ultimately they failed to fulfil expectations; only 5,576 sleepers were supplied by them, and the balance was made up from other sources.

2. *Supply of samples*.—Requests for specimens were complied with, and samples intended for commercial and industrial investigation liberally distributed.

3. *Utilisation conference*.—The writer of the report took part in the Utilisation Conference held at Dehra Dun, March 17th-20th, 1937.

4. *Commercial timbers*.—A list showing the commercial timbers of Assam was prepared, as a preliminary to a Hand-Book of Forest Products of Assam.

5. *Enquiries*.—Various enquiries were answered on timber, bamboos, cane, lac, *agarwood*, Indian rubber, resin, honey, bee's wax, fish-poisons and drugs.

6. *Liaison*.—The usual liaison was maintained with the provincial Silviculturist and Botanical Officer; Specialists at the Forest Research Institute, Dehra Dun; Director of Commercial Intelligence and Statistics, Calcutta; Director, School of Tropical Medicine, Calcutta; the Officer-in-charge, Commercial Museum and Publicity Department, Corporation of Calcutta; and the Cabinet Factory Superintendent, the Gramophone Company, Limited, Dum Dum. Acknowledgments are due for help from all these sources.

7. *Forest Products Museum*.—Samples of raw materials of forest origin and also of products manufactured therefrom are being collected for display with a view to encouraging the public to buy indigenous products. In short, the Museum will serve the purpose of not only a show-room, but will also pave the way for marketing.

8. *Aims and Achievements*.—It appears that some sections of the public are not acquainted with the aims and objects of the Utilization office.

The primary object is to develop the utilization of all the natural resources of our forests, to stabilize prices throughout the province, and to place an increasing supply of marketable products within the reach of the public.

## BENGAL.

### UTILIZATION.

#### I.—GENERAL WORK OF ADMINISTRATION.

The post of Forest Utilisation Officer, Bengal, was held by Mr. W. E. Hodge, D.C.F., from 1st April 1936 to 24th October

1936, and by Mr. C. T. Trigg, D.C.F., from 25th October 1936 to 31st March 1937. The number of days spent on tour by each were :—

Mr. Hodge, D.C.F., 62 days.

Mr. Trigg, D.C.F., 29 days.

The headquarters of the Forest Utilisation Officer, Bengal, were moved from Darjeeling to Calcutta in June 1936. The office of the Forest Utilisation Officer, Bengal, was closed in Darjeeling on 20th May 1936 and reopened on 25th May 1936 at Alipore, Survey Building.

During the year under report the Forest Utilisation Officer, Bengal, was still understaffed, with no funds available for expansion and advertisement. With one temporary clerk and no money, research and enquiry were limited, as the office was fully occupied in dealing with outside enquiries and tenders, and had to make shift with the means at its disposal.

## II.—COMMERCIAL AND EXPERIMENTAL ACTIVITIES.

Unfortunately there has been a falling off in supplies of miscellaneous timbers other than sal (*Shorea robusta*), and *gurjan* (*Dipterocarpus turbinatus*), Divisional Forest Officers being unwilling, and in most cases unable, to supply, especially at current market rates.

In many cases it was not realised early enough that the timbers we were trying to market were not available in sufficient quantities to make marketing an economic proposition.

We have definitely had to avoid canvassing for orders for timbers in the log, other than sal (*Shorea robusta*), *gurjan* (*Dipterocarpus turbinatus*), *sundri* (*Heritiera* spp.) and *civit* (*Swintonia floribunda*).

Sissoo (*Dalbergia sissoo*) is in fair quantities but we cannot guarantee the logs, and the Divisional Forest Officer, Buxa division, states that the best way to sell would be sawn, and that he is not prepared to offer in the log.

Sissoo (*Dalbergia sissoo*) has not been enumerated. In fact for none of the timbers other than sal (*Shorea robusta*) and *sundri* (*Heritiera* spp.) have we accurate outturn figures. But even without enumeration it can be safely said that our stocks of any one good quality timber, with the exception of sal (*Shorea robusta*) in the north and *gurjan* (*Dipterocarpus turbinatus*) in the south, are very limited.

Timbers are being sent for test to the Forest Research Institute, Dehra Dun, but good reports are handicapped by lack of supplies. The public do not realize our unfortunate situation and from enquiries it appears that they have very erroneous idea of the stocks in our forests. That we have had to refuse orders has been a great disappointment and very discouraging, and tends to get the Department a bad name.

Tests made at the Forest Research Institute, Dehra Dun, are frequently of immediate value, but they are of much more value in our efforts to predict the future, and so guide us in our plantation work.

### (1) *Wood technology.*

A key for the identification of 34 Bengal timbers is being prepared at Forest Research Institute, Dehra Dun. Divisions are sending specimens.

### (2) *Timber seasoning.*

(i) *Cedrela toona*.—10 tons of forest grown *toon* (*Cedrela toona*) were sent to Dehra Dun for kiln-seasoning tests for comparison with road-side *toon*. No report has yet been received.

(ii) *Terminalia tomentosa*.—2 logs of laurel (*Terminalia tomentosa*) were kept stored in water for experimental seasoning purposes for a year in Buxa division. After the year, one was found so badly split that it was useless for sawing. The other was perfectly sound and was sawn up into planks and scantlings the behaviour of which is being watched. Splitting of the first log may be due to internal cracks caused when it was felled, though these were not apparent at the time.

### (3) *Timber testing.*

(i) No report on the logs of the following species sent to Dehra Dun, Forest Research Institute, during the year 1934-35 for test on project VIII was received:—

|                                 |         |                         |
|---------------------------------|---------|-------------------------|
| <i>Castanopsis hystrix</i>      | . . . . | Darjeeling.             |
| <i>Terminalia tomentosa</i>     | . . . . | Kurseong.               |
| <i>Anthocephalus cadamba</i>    | . . . . | Do.                     |
| <i>Artocarpus chaplasha</i>     | . . . . | Chittagong Hill Tracts. |
| <i>Gmelina arborescens</i>      | . . . . | Ditto.                  |
| <i>Lagerstrœmia flos-reginæ</i> | . . . . | Ditto.                  |
| <i>Michelia champaca</i>        | . . . . | Ditto.                  |
| <i>Dipterocarpus turbinatus</i> | . . . . | Ditto.                  |

(ii) *Grewia tiliæfolia* and *Grewia vestita*.—Samples of the above species were sent to the Forest Research Institute, Dehra Dun, in

1934-35 for comparative tests from Kurseong. No report has yet been received.

(iii) *Gmelina arborea*, 4 logs.

*Artocarpus chaplasha*, 4 logs.

*Dipterocarpus* spp., 4 logs.

*Michelia champaca*, 4 logs.

Reports on the above logs sent from Chittagong Hill Tracts division to the Forest Research Institute, Dehra Dun, for general quality tests in 1934-35 have not been received.

(iv) *Tectona grandis*.—The following reports were received from Dehra Dun on the teak (*Tectona grandis*) sent from Chittagong Hill Tracts and Kurseong divisions.

Both these consignments have now been completely tested and a table of strength results giving also the strength of Burma and Malabar teak is attached (not included in this report). All values for air-dry tests have been reduced to a uniform moisture content of 12 per cent. for easy and accurate comparison.

Two of the teak trees from Kurseong division were suspected of fungus attack from the appearance of black and brown stain. Doubtful specimens were sent to the Wood Technologist for microscopic examination who reported that they were heavily attacked by fungus. But as their strength figures did not show any deterioration and compared well with those for other trees they have been included in the averages. Broad dark streaks were found in all trees of this consignment. It may be interesting to investigate if it is a characteristic of teak grown in Kurseong division.

Kurseong teak is on an average slightly lighter than Chittagong Hill Tracts teak being 38 lbs. per cu. ft. while the latter is 40 lbs. and although it was suspected of fungus attack, was slightly superior in strength to the latter. The difference between them was however very small. They are therefore combined together under the name of Bengal teak.

*Bengal teak*.—The specific gravity of Bengal teak (average of Kurseong and Chittagong teak) is .56, *i.e.*, about 9 per cent. lower than Burma and Malabar teak. Its average weight at 12 per cent. moisture content is 39 lbs. per cubic foot. It is about 10 per cent. lower in modulus of elasticity and modulus of rupture and about 20 per cent. lower in elastic limit, compression and hardness. But it withstands a considerably higher Max. drop in Impact bending. It has also a slight advantage over Burma and Malabar

teak in having a somewhat lower shrinkage, making it more suitable for furniture.

Bengal teak offered no conversion difficulties except slight gumming of saw-teeth and knife edges, as in the case of all teaks. It machines well, turns well and can be brought to a fine smooth surface by hand without any difficulty. It takes a good spirit polish.

(v) *Ailanthus grandis*.—A specimen log of this species was sent to the Forest Research Institute, Dehra Dun, in 1934-35, from Buxa division, for tests under project I. No report has yet been received.

(vi) *Swintonia floribunda*.—A veneer test report on *Swintonia floribunda* was received from the Forest Research Institute, Dehra Dun, as follows:—

There was every indication that *Swintonia floribunda* would make up into a useful second class plywood but it would have to be processed immediately after felling to avoid damage by insect and fungus.

The timber might be suitable for the match industry provided factories could get supplies free from insect and fungus attack.

Weight of the wood at 12 per cent. moisture content 38 lbs. per cubic foot.

(vii) *Carapa moluccensis*, *Avicennia officinalis*.—2 logs of *bam* (*Avicennia officinalis*) and 6 logs of *pussur* (*Carapa moluccensis*) have been despatched to the Forest Economist, Forest Research Institute, Dehra Dun, for testing their working qualities and for the manufacture of plywood panels from the Sundarbans division.

(viii) *Cryptomeria japonica*—*Bucklandia populnea*.—The following reports were received from the Forest Research Institute, Dehra Dun, on the above timbers:—

“Trade and other names:—Bengal—*pipli*, Assam—*dingdah*.

Habit and distribution:—A large tree with a straight cylindrical stem. Found in the Eastern Himalayas in Darjeeling and Kurseong divisions and in the Khasia Hills of Assam.

Characteristics:—Light reddish brown, lustrous having particularly pleasing effect when peeled, inclined to be interlocked but not sufficient to interfere with its conversion into veneers by the rotary method.

The consignment under review appeared to be fast grown. It had very little sapwood and there was evidence of the fact that this species is subject to attack by pinhole borers. A sweet odour

was noticed while the timber was green, but this faded out during the drying process.

**Supplies:**—Supplies appear to be limited, records showing that conjointly the Darjeeling and Kalimpong divisions can supply only about 130 tons per year. This figure would not qualify the establishing of a factory for conversion of *pipli* alone. It could, however, be used in conjunction with other timbers for the manufacture of plywood.

**Boiling and peeling:**—This species offers little or no difficulty during the peeling process and subsequent manufacturing stages. In fact it is a pleasure to convert and fabricate, very sound continuous tight veneers being obtainable without resorting to previous boiling treatment or special machine technique.

**Strength (Static bending):**—Average maximum load 85 lbs.

**Glue adhesion:**—Average 205 lbs. per square inch.

### Summary.

*Bucklandia populnea* is a very suitable timber for manufacture of a second grade utility plywood and is worthy of further consideration. Due, however, to the possibility of attack of pinhole borers this species should be converted and dried very soon after felling.

*Pipli* plywood can be filled, painted, varnished or polished to a finish suitable for interior fitments, ceilings shop and office fittings, partitions and many other kinds of work.

As stated above the drawback would appear to be the obtaining of supplies in commercial quantities as a result of which it would be necessary to use *pipli* in conjunction with some other suitable species."

*Cryptomeria japonica*.—Test Nos. 139 and 142.—"Due to its exceptionally rapid growth (average 3 rings to the inch) it was found impossible to produce veneers of *Cryptomeria japonica* from Bengal under any circumstances.

Grown in Japan, *Cryptomeria japonica* lends itself to being made up into a reasonably good second grade plywood. Unless the Bengal variety can be considerably slowed down in its growth it cannot be recommended for manufacture into plywood."

(ix) *Michelia champaca*.—The following report was received on the *champ* (*Michelia champaca*) planks supplied from Buxa division to Ishapur Rifle Factory during the year:—

"The results of the trials of the three chests with fittings have shown that whereas the timber *champ* is suitable for the repair of

chests S. A. at bottoms and ends, it is unsuitable for the repair of chests S. A. at lids and sides, owing to the tendency of splits and breaks appearing at screw holes, and it is unsuitable for the manufacture of fittings to chests owing to its being too brittle and easily broken.

It has therefore been decided not to proceed further with the use of this timber."

(x) *Cedrela febrifuga*, Blume—*Cedrela toona*, Roxb.—Two pieces of hill toon (*Cedrela febrifuga*, Blume) and two pieces of plains toon (*Cedrela toona*, Roxb) were supplied to the Ishapore Rifle Factory from Kalimpong division for making machine gun chests. The plains toon was found suitable for their requirements.

(xi) Sal (*Shorea robusta*)—Black siris (*Albizia odoratissima*)—Bishop wood (*Bischofia javanica*).—The following reports were received from the North-Western Railway during the year under report:—

"About 6,000 R. ft. of cornice mouldings were cut from sal, black siris and bishop wood and were supplied to them during the year 1934-35. After seasoning for about six months, the timbers were machined and stored in their machined timber shed. Only about one-third of the quantity mentioned was eventually found to be useable, owing to the timbers having twisted and warped. They report that the black siris was found unsuitable for railway coach work."

(xii) *Lagerstræmia flos-reginæ*.—The following report was received from the Forest Economist, Forest Research Institute, Dehra Dun, through the Divisional Forest Officer, Silvicultural division, on *Lagerstræmia flos-reginæ* from Chittagong and *Lagerstræmia hypoleuca* from the Andamans:—

"From the tests carried out there seems to be no difference of any practical importance between *Lagerstræmia hypoleuca* from the Andamans and *Lagerstræmia flos-reginæ* from Chittagong. The former is, however, slightly weaker in compression and hardness. Both of them have been grouped together under the name of "jarul" in the official list of trade names."

(xiii) *Swintonia floribunda* (civit)—*Sterculia alata* (gorok).—Two logs of civit and gorok were supplied to the Western India Match Co., Calcutta, from Chittagong Hill Tracts division, for testing their suitability for match manufacture or any other purpose. The following report was received from the firm:—

"The result of our trial with civit and gorok for match wood has not turned out satisfactory.



*Civit* can be peeled for splints but is rather hard veneer, surface uneven. The quantity supplied was too small for complete test, but from what has been seen in the peeling process, we are not in favour of using this species.

*Gorok* is entirely unsuitable on account of its hardness. It cannot be peeled.

Both the species are heavy and therefore hardly suitable for case-boards."

(xiv) *Avicennia officinalis* (bæn).—Ten tons of bæn logs were supplied to the Gramophone Company, Dum Dum, for experiment in making gramophone boxes, but it was found unsuitable for the purpose.

#### (4) *Wood preservation.*

(i) *Acrocarpus fraxinifolius*.—The following report on the durability tests of 200 treated sleepers of *Acrocarpus fraxinifolius* was received from the Chief Engineer, Eastern Bengal Railway, Calcutta:—

| Mileage where laid.  | Number laid. | Date when laid.      | Report on the behaviour of sleepers.   |
|--|--------------|----------------------|--|
| 296/5 to 296/8 on the main line between Barsee and Kachna. | 200          | 19th September 1935. | 56 Nos.—Good.<br>134 Nos.—Hair cracks.<br>9 Nos.—Slight cracks.<br>1 No.—Big cracks. |

The cracks are all longitudinal to the sleepers and appear to be originating from spike holes in some cases.

#### (5) *Minor forest products.*

(i) *Gurjan oil*.—Tapping of *gurjan* oil departmentally as an experimental measure was continued in the Chittagong division. Different methods have been adopted and it is observed that the flow of oil is scanty during the period from June to October. It is also observed that the hot weather is the only time suitable for tapping. The average outturns of oil for the year by different methods are shown below:—

- (1) By local method—5 seers  $4\frac{1}{2}$  tolas per tree.
- (2) With lip method—7 seers 15 tolas per tree.
- (3) Local methods by local tappers—4 seers  $4\frac{1}{2}$  tolas per tree.

(ii) *Gurjan oil*.—A sample tin of *gurjan* oil was supplied to the Director of Industries, Bengal, from the Chittagong division in

1933-34 for test as to its suitability for paint manufacture but no report has yet been received.

(iii) *Bark of Betula*.—The following results were obtained from the sample bark of *Betula* species after examination at the Forest Research Institute, Dehra Dun :—

|                         |                |
|-------------------------|----------------|
| Moisture . . . . .      | 46.8 Per cent. |
| Essential oil . . . . . | 0.08 „         |

The oil was light greenish yellow in colour and strongly smelled of winter-green oil. That it contained methylsalicylate was proved by isolating salicylic acid M. P. 154—55° C. But the oil content appears to be too low for profitable extraction of the oil.

(iv) The following were supplied to the Principal, Government School of Dyeing and Printing, Cawnpore :—

|   |             |
|---|-------------|
| Bark of <i>Rubia cordifolia</i> . . . .   | Kalimpong.  |
| Bark of <i>Chukrasia tabularis</i> . . .  | Kurseong.   |
| Bark of <i>Ceriops roxburghiana</i> . . . | Sundarbans. |

(v) Specimens of the following were sent to the Biochemist, Forest Research Institute, Dehra Dun, from Kalimpong division :—

|                                     |   |
|-------------------------------------|---|
| <i>Dalbergia stipulacea</i> . . . . | } Bark and roots 10 lbs. of each.<br>Seeds and roots 10 lbs. of each.<br>Twigs and roots 10 lbs. of each. |
| <i>Entada scandens</i> . . . .      |   |
| <i>Millettia pochycarpa</i> . . . . |   |

(vi) *Grass*.—11 different specimens of grasses were sent to the Forest Research Institute, Dehra Dun, from the Dacca-Mymensingh division. Ten species were identified as :—

- (1) *Eleusine indica*.
- (2) *Eleusine ægyptiaca*, Desf.
- (3) *Eragrostis interrupta*, Beauv.
- (4) *Eragrostis tenella* R. & S.
- (5) *Panicum flavidum*, Retz.
- (6) *Setaria glauca*, Beauv.
- (7) *Digitaria longiflora*, Pers.
- (8) *Eragrostis amabilis*, W. A.
- (9) *Eragrostis stenophylla*, Hochst.
- (10) *Paspalum serobiculatum*, Lin.

The eleventh specimen could not be identified for want of flowers.

#### (6) *Paper pulp*.

(i) Arrangements were made to supply one ton of *gengwa* (*Excoecaria agallocha*) from Sundarbans division.

(ii) One ton of *malata* (*Macaranga denticulata*) timber without bark was sent to Forest Research Institute, Dehra Dun, from Lataguri for mechanical pulp experiments.

(iii) *Mitenga* (*Bambusa tulda*) 5 tons.

*Dolu* (*Teinostachyum dullooa*) 5 tons.

*Kaliseri* (*Oxytenanthera auriculata*) 2 tons.

The above bamboos were sent to the Forest Research Institute, Dehra Dun, during the year 1935-36, from Chittagong Hill Tracts division, for further test of paper pulp, but no report has yet been received.

#### (7) *Tans.*

The Superintendent, Bengal Tanning Institute, informed us that the five maunds of *goran* (*Ceriops roxburghiana*) bark sent from the Sundarbans division were distributed to different tanners through the Indian Government Trade Commissioner at Hamburg, but none of the tanners was interested.

#### (8) *Wood working.*

(i) *Swintonia floribunda*—*Sterculia alata*.—Sample logs of the above species from Chittagong Hill Tracts division were supplied to Messrs. Mansfield and Sons, Calcutta. They are interested in *Swintonia floribunda* only and hope to be able to introduce it on the market but the price f.o.r. Calcutta is against it.

(ii) The following samples of timbers were supplied from Kalimpong division:—

(a) Birch (*Betula* spp.) to A. C. Mohamed, Esqr., Calcutta.

(b) Birch (*Betula* spp.) and hill *malata* (*Mallotus nepalensis*) timbers to Messrs. Bharat Industries, Howrah.

(c) *Lampati* (*Duabanga sonneratioides*) planks to Messrs. Mansfield & Sons, Calcutta.

(d) Hill and plains *malagiri* (*Cinnamomum cecidodaphne*) to the Manager, Army and Navy Stores, Calcutta.

(e) *Sundri* (*Heritiera* spp.) to the Calcutta Port Commissioners, for the road way on the Howrah Bridge.

(iii) No report on the specimens of sal (*Shorea robusta*) sleepers sent to Ceylon and the Sudan has yet been received.

(9) *Miscellaneous.*

(i) *Pneumatic equipment for bullock carts.*—A cart equipped with Dunlop pneumatic tyres was tried in the Dacca-Mymensingh division for the extraction of poles. The Divisional Forest Officer reported that it was unsuitable owing to the nature of the country.

(ii) The usual liaison was maintained with Divisional Forest Officers, the Timber Advisory Officer to the Railway Board, the Timber Adviser to the High Commissioner, India House, London, and the Forest Research Institute, Dehra Dun.

(iii) We have continued our efforts to get freight rates reduced.

Box and match woods were given all round reductions from Buxa division. *Siris* (*Albizzia procera*) and *adal* (*Sterculia villosa*) were included in the special rates, and *toon* (*Cedrela toona*) was included after the close of the year.

Reduction in the fire-wood rates on the Dacca-Mymensingh division was also secured, and negotiations were continued beyond the close of the year.

Railways and Steamship Companies are generally unwilling to consider reductions in freight unless we can offer considerably increased business, and this is not always possible owing to limited supplies.

## BIHAR.

## I.—GENERAL WORK OF ADMINISTRATION.

The Forest Research Officer, who was also the Working Plan Officer, held charge of the Utilisation Branch. During the year under review he lost the assistance of the Utilization Ranger who was sent to Kolhan division for over six months, and consequently worked under handicap.

## II.—COMMERCIAL AND EXPERIMENTAL ACTIVITIES.

*Grading rules for Timber.*—These rules, compiled last year upon the Empire rules for sawn timber, have now been revised to include Burma teak grading rules for squares, Burma rules for logs, specifications for railway sleepers, and rules for poles based on those drawn up at Dehra Dun for electrical purposes. They thus cover the whole field of timber extraction and sale. Delay has occurred in printing, but they are now to be produced in pocket book form.

*Railway freights.*—Last year substantial freight concessions were obtained for poles extracted from long leads under thinning schemes in Porahat and Kolhan divisions. This year similar concessions have been granted to stations of Chaibassa division. Representations have also been made for reductions in charcoal freight to Calcutta, and there is reason to believe that these will be successful. The aim is to place all thinning material as poles or charcoal upon the Calcutta or colliery markets from leads of 15-20 miles from the nearest railway stations, or even more in the case of charcoal, leaving firewood to be extracted from the nearer distances.

*Publicity and propaganda.*—It was with regret that we expressed inability this year to take part in the Industrial Exhibition held in Ranchi, owing to the absence of the Utilisation Ranger on whose shoulders falls the task of organising the exhibits. At the Divisional Forest Officer's request, twenty 2' sample planks of commoner Bihar timbers were sent to the Santal Parganas' Agricultural Exhibition. Upon each plank was posted a description of its uses, weight and working qualities. Photographs of the Bihar Ascu white-ant attack experiment were also included.

Towards the close of the year, the Editor of *Industry*, Calcutta, requested an article on Bihar timber for the special July issue which he was devoting to the Wood Industry. This was done. The useful summary on "Seasoning of Timber" from the Burma Hand Book was also sent in, illustrated by the Forest Research Institute poster. With the Forest Research Institute's own valuable extensive contributions, the issue forms a very useful summary of much information hitherto only found scattered in many books, and our Utilisation ledger files will receive much additional information.

*Posters.*—The criticism levelled at the Institute last year for sending to the Patna Exhibition original Utilisation posters, which unfortunately got spoiled by rain, instead of reproducing them by the hundred, for posting up in all Range Offices and timber depôts, has borne abundant fruit. Four extremely useful posters on "Seasoning of timber", "Tool handles", "Treated wood" and "Strengths of Indian timbers" have been produced, and these have been converted in this Province into linen backed wall pictures, for distribution to all Divisional Forest Officers, and Range Officers, P. W. D. Engineers, Engineering Colleges, District Engineers, District Officers and selected private firms. District Magistrates, and Engineers are being requested either to display them in their offices in prominent places or to send them

to some one in their jurisdictions, who may find uses for them. In this way it is hoped to disseminate widely throughout the Province, knowledge on the proper treatment of timber which the Institute has discovered for us. Only in ways such as this, and by increasing propaganda, can the full benefits of the Institute become widely known and brought into universal practice. The Patna Exhibition last year, followed this year by the Lucknow Exhibition, has brought the Institute into direct contact with wood users. As long as the Institute through local utilisation officers supports such exhibitions, one need never fear that they will lose contact with the needs of the people.

*Enamelled signboards advertising.*—Bihar forest products were exhibited in the following East Indian Railway stations:—

Howrah, Burdwan, Raneegunge and Jheria.

### *Summary of Results.*

In pursuance of the utilisation policy, the Utilisation Officer surveyed markets and established contact between the forest purchasers and markets with the following results:—

*Buxar Jail.*—In the previous year a consignment of sal sleepers and scantlings passed through the Utilisation branch to the Buxar Jail. The consignment was found unsatisfactory and much of it was rejected by the Jail. Absence of precise grading rules was responsible. This unfortunate experience gave the necessary stimulus for collecting and editing more efficient rules which will be used henceforward whenever necessity arises. In the year under review, another consignment was bought by the Jail. The consignment was passed according to the new rules and the Jail expressed satisfaction.

*Tatas market.*—The Utilisation Officer visited the different industrial firms in Tatanagar. The visit to the Tata Iron and Steel firm enabled him to make a survey of its timber requirements. The firm regularly buys teak, *bonsum*, *champ*, padauk, sal, a little *bija* and *semul*. *Bonsum* and *champ* are used in large quantities for making patterns. Teak, padauk, and *bija* are used for furniture. Sal is used as railway sleepers and as shoring boards. *Semul* is used for centering oven arches.

Teak and padauk cannot be replaced altogether by any furniture wood of Bihar, as the size of squares wanted is not found in sufficient quantity. Sal supplies are obtained from this province. The annual requirement of *semul* is 100 tons, the whole of which order was secured. A trial order was also placed for a wagon load

each of *chilbil* (*Holoptelea integrifolia*) and *gumhar* from the Palamau division, to be used for pattern making. These two woods have qualities similar to that of *bonsum* and *champ*; they are light, even grained, easily workable, and less responsive to seasonal swellage and shrinkage. If in practice these woods are found suitable, sustained supplies can be arranged from Palamau division to satisfy the requirements of this firm.

Grouped around Tatas, several subsidiary industries dependant on them for iron and steel have sprung up. The Indian Wire Products, Ltd., consume large quantities of *salai* for making small kegs, and these have hitherto been obtained from Zamindari forests of Palamau. With the inevitable decrease in supplies from these sources, Government forests will be called upon to make up the deficiency. The Indian Cable Company uses 200 tons of Andaman *dhup* annually for Cable drums. *Semul*, *chatni* (*Alstonia scholaris*) and *Albizzia stipulata* could be used as substitutes, but supplies are inadequate. *Salai* from Palamau has been tried but is too heavy.

The Agrico Company buys *geon* (*Excacaria agallocha*) from Bengal. *Semul* could be used as a substitute for this wood also.

*Boxwoods*.—Several enquiries for boxwoods were also received from Calcutta. It is evident that as India becomes more industrialised, the demand for boxwoods is bound to increase. Without wishing to encroach too much on the Calcutta market, the natural outlet for Bengal, Assam, Burma and Andaman supplies, we should at least attempt to satisfy the needs of our own Province. Kolhan division is favourably situated for supplying in this respect and the Samta Valley in Saranda.

*Planing and planking woods*.—These woods include *gumhar*, *chilbil*, *bhurkund* (*Hymenodictyon excelsum*), *kadam* and *champ*. One market has already been indicated at Tatas. Other enquiries from Calcutta show that there is considerable scope for *gumhar* for light furniture. One man wanted 4,000 tons annually in order to make cheap sandals for export to Japan to compete with those imported now from China. I reluctantly recommended *bonsum* from Assam as we could not supply. Plantations could usefully be made in Kolhan and Palamau for supplying the demand.

*Teak*.—This wood is always in demand for furniture and constructional work and it is advisable to create plantations to supply part of it. Palamau is favourably situated for supplying the Gangetic Plain and the United Provinces where apparently teak is cut back by frost. Saranda and Porahat might add their quotas.

*Plantation aim.*—A modest aim would be to supply 1,000 tons each annually, of boxwoods, planking woods and teak. Reckoning one ton sawn to be equivalent to  $1\frac{1}{2}$  trees of 6' girth, and fifty trees to the acre—30 acres of plantation of each class might be created each year.

*Hardwoods.*—Attempts were made to introduce *asan*, *karam* (*Adina cordifolia*), *bija*, and *siris* from Singhbhum into the Bareilly market, but the freight proved prohibitive except in the case of *karam* for which a market might be found.

An order for  $\frac{1}{2}$  ton of *asan* planks of 6"—11" and 11" and over was received. Despite our best endeavours enough planks could not be collected to specification. The trees though big enough, over 7' girth in the marking lists, were hollow or forked, legacies from former heavy fellings, so that few planks wider than 11" could be obtained. Delay occurred in signing the lease and conversion by the contractor did not take place until February, though permission for advance fellings was given. Degrade in seasoning in consequence set in, resulting in excessive splitting especially in the thicker planks of over 1" thickness.

The open gable end of the seasoning shed was a contributing factor as the hot winds of March and April beat down upon the stacks below. In future, felling must take place in the rains, and conversion then or early cold weather, if success is to be expected.

A plywood merchant of Calcutta enquired for a sample of wood named "*pepro*". It was identified as *Gardenia latifolia*, which was not available in the size wanted. *Chilbil* as a substitute was suggested. The enquiry resulted in an order for *chilbil* to the Divisional Forest Officer, Palamau division.

Another firm from Calcutta enquired for "*pepro*". A sample of *Mitragyna parvifolia* was sent as a substitute. No reply has been received.

Messrs. Mullik & Co., of Patna, at their request, were supplied with a piece of *siris* square for the manufacture of gunstocks. Results are awaited.

*Brushbacks.*—Samples of the following species were sent to Messrs. The Brushware Ltd., Cawnpore, for testing for manufacture of brushbacks:—

1. Ebony (*Diospyros melanoxylon*).
2. Satin wood (*Chloroxylon swietenia*).
3. Sissoo (*Dalbergia latifolia*).



4. *Bhurkund* (*Hymenodictyon excelsum*).
5. *Chilbil* (*Holoptelea integrifolia*).
6. *Siris* (*Albizzia procera*).
7. *Gumhar* (*Gmelina arborea*).
8. *Kaka* (*Bridelia retusa*).

Ebony, satinwood and sissoo were pronounced to be suitable for high class (toilet) brushes; *bhurkund* and *chilbil* suitable for kit brushes, and the others for miscellaneous brushes. Sample brushes have been added to our Economic Collection. Although Indian manufacturers pay a good price, their consumption appears to be small.

Enumerations of hardwood species made in Saranda and Kolhan the previous year has enabled us to work out a scheme for supplying these annually and a contractor has been offered a three year lease monopoly. *Asan* finds a ready market, so also does *bija*. *Karam* and *Mitragyna*, mango and *jamun* are not so well known, but by concentrating sales through one man it is hoped to get the sales of these and lesser important species worked up.

#### *Uses of lesser known timber.*

*Palamau division*.—Messrs. F. N. Gooptu & Co.'s report on timber sent to them in September 1935 was received during this year. These were tested for suitability for the manufacture of pen-holders and pencils. The report is as below:—

*Chilbil* }  
*Salai* } are porous and coarse grained and not suitable.

*Bhurkund*.—Rather suitable for pen-holders and very cheap quality pencils but not as good as the two following.

*Wrightia tomentosa*. } Very close grained, moderately  
*Holarrhena antidysenterica*. } soft and work up to a fine  
 smooth surface and as such are most suitable for pen-holders.  
 For pencils they are hard and the white colour is a drawback for use in superior qualities. They can, however, be used for cheap qualities with a good result.

*Foreign Market*.—An attempt was made to create a market for Singhbhum *asan* (Indian laurel) and Palamau satinwood in England, and for satinwood in Japan. There was no immediate demand in the English market, whereas Japan placed their order with Madras.

*Tool handles*.—Our efforts to secure a contractor for making tool handles of *dhaura*, *kusum*, *dhaman*, *kendu*, *asan* and *sidha* have

advanced a stage nearer to success. A man of Ranchi, well versed in mechanical engineering, is getting keen and promises to set up a plant next cold weather. All the information which could be collected has been placed at his disposal. The recent pamphlet written on *yon* (*Anogeissus acuminata*) by the Burma Utilisation Officer is proving of great assistance, and the Forest Research Institute have also been very helpful. Emphasis is laid on the necessity for efficient seasoning prior to fashioning.

*Palamau division.*—A report was received from the Chief Mechanical Engineer, Bengal Nagpur Railway Workshop at Kharagpur, about the suitability of various timbers of which tool handles were sent for testing. It is given below:—

| Name of species.                      | No. of handles tested. | Remarks.  |
|---------------------------------------|------------------------|---|
| <i>Kusum (Schleichera trijuga).</i>   |                        |   |
| Sledge hammer shafts . . .            | 2                      | Put in service on 14th October 1936. One still in service in September 1936. Found satisfactory.  |
| Hand hammer shafts . . .              | 2                      | Ditto.  |
| File handles . . .                    | 2                      | Suitable for shop use but requires to be a little smaller and fitted with ferrules.   |
| <i>Dhman (Gracilia tiliacifolia).</i> |                        |   |
| Sledge hammer shafts . . .            | 2                      | Put in service on 14th October 1936 still in service in September 1936 and found satisfactory.  |
| Hand hammer shafts . . .              | 2                      | Ditto.  |
| File handles . . .                    | 2                      | Same remarks as under <i>kusum</i> .  |
| <i>Dhaura (Anogeissus latifolia).</i> |                        |   |
| Sledge hammer shafts . . .            | 2                      | No good.  |
| Hand hammer shafts . . .              | 2                      | Better than our present issue; should be given a further test.  |
| File handles . . .                    | 2                      | Same remark as under <i>kusum</i> .   |
| <i>Bharul (Ochloxydon siiclenia).</i> |                        |   |
| Sledge hammer shafts . . .            | 2                      | One tried in smithing work and broke in 2 hours time and the other is still in service good.  |
| Hand hammer shafts . . .              | 2                      | One tried in levelling tube ends and broke in half an hour time and the other tried is cankling from 23rd January 1936 to 26th February 1936. |
| File handle . . .                     | 2                      | Good.<br>Quite suitable for shop use but must be fitted with ferrules.  |

|                                    |  |
|------------------------------------|--|
| Size of sledge hammer shafts . . . | 3 ft. $\times$ 1½ inch $\times$ 1½ inch. |
| Size of hand hammer shafts . . .   | 1 ft. 6" $\times$ 1½ in. $\times$ 1 in.  |
| File handles ] . . . . .           | 5 inches long.                           |

The report on *dhaura* and *bharul* is rather surprising and may be due to timber not being seasoned properly. An enquiry was made if there were any knots in the shafts supplied and it was reported there were no knots in any of the shafts. Later it was reported that the *kusum* sledge hammer shafts were still in service in December 1936.

Pieces of following timbers were sent to Dehra Dun for making up as tool handles for museum specimens:—

- (a) *Kendu* (*Diospyros melanoxylon*).
- (b) *Sidha* (*Lagerstræmia parviflora*).
- (c) *Dhaura* (*Anogeissus latifolia*).
- (d) *Kusum* (*Schleichera trijuga*).
- (e) *Asan* (*Terminalia tomentosa*).
- (f) *Dhaman* (*Grewia tiliæfolia*).

*Poles*.—Owing to the high price of copper wire this year, the Telegraph Department contracts were upset, and the Darbhanga-Laheriasarai scheme for using Ascu pressure treated sal poles fell through. The Keonjhar State scheme appears also to have fallen through for the same reason.

The price of steel which has risen 50 per cent. in last six months has stimulated the demand for Ascu electrical transmission and service lighting wooden poles. Several enquiries have been made. Had treated stocks been available the whole of the Darbhanga order for 350 poles could have been secured. A part of the Ranchi extension order has also been lost for the same reason though there are prospects of securing the remainder of it. Orders towards the close of the year were placed for collecting 600 poles for keeping in stock against anticipated orders.

#### (1) *Wood technology.*

Nil.

#### (2) *Timber seasoning.*

With the object of demonstrating the method of air seasoning, a seasoning shed has been constructed for Rs. 600 at Chhipadohar in Palamau division where forest purchasers can season planks and boards at a nominal charge.

(3) *Timber testing.*

Nil.

(4) *Wood preservation.*

Messrs. Callender's Asen preservative plant was transferred from Kodarna to Chippadohar, in anticipation of securing the Telegraph order. It has lately been sent to Singhbhum for electrical pole treatment.

(5) *Minor Forest Produce.*

*Match woods.*—Although enquiries were received, negative replies had to be given as our soft wood resources were inadequate.

*Paper pulp.*—Palamau bamboo forests are being partly utilized for paper pulp. A paper mill is reported to be in erection at Dehri-on-Sone. This will lead to more utilization of the bamboo of Palamau division.

(6) *Paper pulp.*

Nil.

(7) *Tans.*

Nil.

(8) *Grasses.*

An enquiry was received from England for supplying samples of grass mats. Samples of *sabai* mats have since been sent and if approved good business should result.

*Fodder grass.*—With the object of ascertaining the distribution and quality of fodder grasses, a large number of grass specimens have been collected and identified. Those growing extensively will be tested for food value and palatability.

(9) *Hay.*

*Palamau division.*—The export of hay from the division has developed considerably of recent years, through the enterprise of the lessee. *Andropogon contortus* is exported as the standard hay. The spear is removed by knocking it off as each handful is cut. "Blue" grass (not identified) makes the best quality hay. A coarse grass with thick stalk growing along the *nala* banks makes another good hay. Standard hay was sent to the Agricultural

Chemist at Sabour for analysis the result of which is given below:—

| Local composition.<br>Percentage on dry matter.      | Digestible constituents.<br>Percentage on dry matter. |
|--|---|
| 7.66 Moisture % (in air dry sample).                 | 0.98 Ether extract %.                                 |
| 1.42 Nitrogen %.                                     | 4.43 Protein %.                                       |
| 2.0 Ether extract %.                                 | 12.61 Fibre %.  |
| 8.9 Crude protein %.                                 | 30.45 Nitrogen free extracts including carbohydrates. |
| 22.9 Crude fibre %.                                  | 35.2 Starch equivalent per 100 lbs.                   |
| 51.6 Nitrogen free extracts including carbohydrates. |   |
| 14.63 Ash %.   |   |

Chemical analysis shows that the grass has good value for stock. Samples of various other grasses were also sent for analysis and a small quality of each to Dehra Dun for identification but no reports have been received so far.

(10) *Wood working.*

Nil.

(11) *Miscellaneous.*

*Floating.*—For some time past, the Forest Department has been endeavouring to develop the floating of forest produce down the larger rivers of Bihar. Unfortunately most of them are interrupted in their courses by fields of rocks forming dangerous rapids, which render them un-navigable. The cost of improving the floating facilities by blasting out such rocks has till recently been considered prohibitive. The north Koel, for example, which drains Palamau division running northwards into the Sone, and later into the Ganges near Patna, is very favourably situated for development, but an original estimate of two lakhs, coming at the time of the world depression was an effective bar to progress.

Experiments this year have shown that the full width of the river need not be cleared. A channel 20' wide and three quarters of a mile long has been driven at Kechki through the lowest of several fields of rocks in this river, at a cost of only Rs. 530, and it is now expected that the whole river can be made floatable for less than Rs. 10,000. A trial snake-like raft of bamboo bundles tied nose to tail recently successfully negotiated the newly prepared channel.

With the completion of the project the people of Patna and of the thickly populated Gangetic Plain in the neighbourhood will be enabled to purchase, at a much reduced cost, poles and bamboos.

The raw materials for building comfortable houses in which to live, and to use firewood instead of cordung for cooking. After food and clothing, nothing is more essential to their happiness. New paper mills using bamboos as raw materials will also greatly benefit, while the Department itself can look forward to increased revenues from hitherto comparatively inaccessible areas.

A contractor in Porahat encouraged by our departmental efforts at floating bamboos in the Southern Koel last year has this year rafted 25,000 bamboos to his own and to our advantage.

*Miscellaneous.*—Mr. S. Kamesam, the Timber Development Officer of the Forest Research Institute, paid a hurried visit to Ranchi and interviewed the Superintending Engineer at Ranchi with the writer in order to work out schemes for a more rational and extensive use of Indian timbers.

*Utilisation Conference at Dehra Dun.*—A Utilisation conference was held in March at Dehra Dun, and was attended by delegates from nearly all of the Provinces in India including this Province and also some of the more important States. It is the first conference held for at least fifteen years and signalises a holder Utilisation policy throughout India. Every Province agreed to make Utilisation the special responsibility of one of its officers. A special Timber Development Branch was opened at Dehra Dun from April 1st, which will be responsible for producing designs, plans and estimates for bridges and buildings of treated timber. These, especially those for bridges should be very useful to engineers. We can scarcely expect them to use structures of timber unless we make it easy for them to do so.

Bengal brought forward a proposal, which had been suggested by this Province eighteen months previously in the Institute's Triennial Report, namely that a Utilisation Branch and showrooms for the Provinces interested, should be opened in Calcutta. This proposal was carried unanimously in committee by the representatives of Bengal, Bihar and Assam and was accepted by the Conference. The Andamans will probably also co-operate. Details are now being worked out for submission to the Governments of the Provinces concerned, and to the Forest Research Institute.

## - BURMA.

### I.—GENERAL WORK OF ADMINISTRATION.

The post of Forest Economist was held by Mr. M. N. Gallant, Deputy Conservator of Forests, from 1st April to 15th May 1936, when he was relieved by Mr. H. A. Maxwell, Assistant

Conservator of Forests, who held charge of the post till 10th November 1936 and by Mr. Gallant for the rest of the year under report.

## II.—EXPERIMENTAL ACTIVITIES.

(i) *Summary of the chief activities of the year under report.*

2. The chief activities of the year are summarised below, the details being given later in the sub-sections concerned:—

(a) Arranging for supply and passing of:—

5,000 B. G. *pyinkado* (*Xylia dolabriformis*) sleepers for the Karachi Port Trust through the North Western Railway.

73,000 B. G. *pyinkado* sleepers (3 years contract of which 47,000 supplied during the year) for the North Western Railway.

8,000 special-size *pyinkado* sleepers for the North Western Railway, Karachi.

(b) Passing 1,920 tons of Indian 1st class quality teak squares according to the *Seaman-Limaye Rules for the Grading of Teak squares* for the North Western Railway.

(c) Arranging for the supply of samples of cross-arms for telegraph poles of *pyinkado*, *padauk* (*Pterocarpus macrocarpus*) and *in-kanyin* (*Dipterocarpus* spp.) for the Post Office Stores Department, London.

(d) Conducting experiments in conjunction with Princes Risborough on the variation of moisture content of *in-kanyin* and teak strips during transit to England.

(e) Arranging for supply of teak samples to Princes Risborough from various forests to study their comparative qualities.

(f) Arranging for supply of samples of teak, *taukkyan* (*Terminalia tomentosa*), *in-kanyin*, *padauk* and *pyinkado* to Princes Risborough for natural durability and fire-proofing tests.

(g) Conducting tests on the efficacy of different preservatives against white ant attack on timber both at Rangoon and Pyinmana.

(h) Conducting further experiments on end-coating teak logs at Kyetpyugan Depôt, Insein division, with various end-coating mixtures.

- (i) Arranging for supply of teak samples of varying rates of growth from different forest areas for strength tests at Dehra Dun.
- (j) Arranging for supply to the Burma Railways a sample consignment of *kazao* (*Heritiera fomes*) sleepers from the Delta division for trial.
- (k) Working up further data in connection with future royalty proposals.
- (l) Revision of the *Standard for Jungle Rejection of Teak logs*.
- (m) Preparation of notes on a tour through India to study the timber market.
- (n) Investigation into the control of matchwood supplies and revision of royalty rates.
- (o) Answering miscellaneous enquiries on Burma timbers, lac, cutch, paper pulp, bamboos and other minor forest produce.

3. During the year under report about 3 months were spent on tour—two months in India to study the timber market and one month on sleepers passing, collection of logs, etc.

4. The only new publication of the year was Economic Series Pamphlet No. 9, "*Note on yon as a hammer handle wood*", a concise summary of the properties of yon, its availability, milling, seasoning, costs, prices, etc.

In addition, a print of the tentative rules of the *Standard for Jungle Rejection of Teak logs* was circulated to Forest Officers and firms interested.

## (ii) *Details of activities.*

### (1) *Wood technology.*

5. As in previous years there were no additions to the standard collection of timber specimens authenticated by botanical specimens due to the post of the Forest Botanist being held in abeyance.

6. Hand samples,  $6'' \times 3'' \times \frac{1}{2}''$  of the more important economic timbers were supplied to many enquirers in Burma, India, the United Kingdom and elsewhere.

7. Routine identifications of timbers were carried out for numerous enquirers. The more common timbers were identified by hand lens examination in Rangoon. Microscopic examination was carried out at Dehra Dun, to whom acknowledgments are due for help given.



Timbers for which identification was called for during the year include the following:—

*Nabe*—*Lannea grandis*.

*Thitpwe*—*Elæocarpus* sp.

*Thitni*—*Amoora rohituka*.

*Lelun*—*Sapium* sp.

*Chinyok*—*Garuga pinnata*.

*Didu*—*Bombax insigne*.

*Teak*—*Tectona grandis*.

*Taukkyan*—*Terminalia tomentosa*.

*Pyinkado*—*Xylia dolabriiformis*.

*Bambwe*—*Careya arborea*.

*In-kanyin*—*Dipterocarpus* spp.

8. Two pieces of *kanjīn* (*Dipterocarpus* spp.) were sent to the Conservator of Forests Research, Forest Research Institute, Kepong, Selangor, F. M. S., for marine borer tests.

9. During the year under report 107 pieces of teak from different forests were sent to Dehra Dun to study the strength of teak of different rates of growth.

10. Samples of teak from different localities in Burma were sent to Princes Risborough to study their qualities for dealing with enquiries as to the variation in the quality of teak appearing on the British market. The report on these samples was received during the year under report and circulated to the teak lessees who contributed the samples.

## (2) Timber seasoning.

11. All kilns gave satisfactory service throughout the year. The three large fan kilns dealt with 31 runs cubing 11,717·8 c.ft. as against 31 runs cubing 11,781·3 c.ft. in 1935-36. Twenty-eight of these runs were of *yon* (10,763·8 c.ft.), 2 of *yinma* (*Chukrasia tabularis*) (652·0 c.ft.) and 1 of *tauikkyan* (*Terminalia tomentosa*) (302·0 c.ft.).

12. The 75 c.ft. fan kiln did 12 runs cubing 826·1 c.ft. as against 12 runs cubing 870·2 c.ft. last year. The runs included 4 of *kanyin*, 1 of *pyinkado*, 2 of *binga* (*Mitragyna diversifolia*), 4 of *hnaw* (*Adina cordifolia*) and 1 of *padauk* (*Pterocarpus macrocarpus*).

13. The 5 c.ft. model kiln was used for experiments on the efficiency of a number of compounds for end-coating timber during kiln-seasoning.

14. Actual running expenses, exclusive of depreciation, were Rs. 17,184-6-9 as against Rs. 17,219-10-6 for 1935-36. The total expenditure of the section inclusive of depreciation charges was Rs. 20,910-14-9, of which Rs. 15,290-14-9 is directly chargeable to the cost of producing 12,543.9 c.ft. of seasoned timber at the rate of Re. 1-3-8 per c.ft., as against Re. 1-3-4 last year. The figure is satisfactory when it is borne in mind that almost all the timber dealt with was 2½" thick. It is estimated that for 1" boards, the seasoning charges can be reduced to as low as 6 annas per c.ft.

15. Notes on some of the runs are given below:—

*Taukkyan (Terminalia tomentosa).*—The charge consisted of 1½" boards in varying widths to 16". The moisture content was reduced from 38.0 per cent. to 11.5 per cent. in 21 days with no appreciable degrade. The new process recommended, of frequent steaming treatments, was employed.

*Kanyin (Dipterocarpus spp.).* Four runs on 1½" flooring strips were made. Results indicate difficulty with timber green from the saw, but the drying of partly air-dried stock is easier, quicker and produces better material. A severe schedule was found to be better than a mild one, but the temperature should not be raised too high. Humidity should be kept low.

It would seem that timbers containing oleo-resins, such as in and *kanyin*, should be air-seasoned for six weeks prior to kilning.

*Pyinkado (Xylia dolabriformis).*—The charge consisted of 3½" plants specially cut for telegraph arms for shipment to England. Owing to the thickness of the timber, a mild schedule was maintained. It took 70 days to dry from 50 to 20 per cent. It would appear preferable to air-dry thick material of this sort down to 30 per cent. prior to kilning.

*Padauk (Pterocarpus macrocarpus).*—The load was of 1½" boards of widths varying to 17". It took 19 days to dry from 22 to 10 per cent., with very little degrade.

16. A special study of various methods of kiln operation was started during the year. A 2½" run of *yon* was subjected to the method of day heating and over-night cooling. Preliminary results indicate that drying by this method is slower with material of this thickness than is the case with the method involving

continuous heating, though there may be a saving in power and steam. Further investigation is being made.

Other methods of kiln operation to be tried out include Oscillating treatments of temperature and humidities at fixed intervals and periodic reversal of air circulation.

17. *Air seasoning*.—The recording of data on several *yon* stacks carried over from last year was continued until they were either taken over by the workshop or sent to the kilns to finish off the seasoning. Eighteen further stacks of the same species were erected and placed under observation during the year. Of these seven were later unstacked and the seasoning completed in the large kilns, as an urgent call for the timber was made by the workshop. In addition to *yon*, five other species, *binga* (*Mitragyna diversifolia*), *hnaw* (*Adina cordifolia*), *padauk* (*Pterocarpus macrocarpus*), *taungthayet* (*Swintonia floribunda*), *pyinkado* (*Xylia dolabriformis*) were also handled for general air-seasoning. Two of the species, *taungthayet* and *pyinkado* were taken over by the workshop, while the remaining three species are still under observation.

18. In connection with the storage of all timbers in the storage sheds, sample boards are now placed in each pile and they are weighed and measured from time to time so that the actual drying rate of each pile is on record.

19. The research work on teak has been concluded and the results are being analysed and will be dealt with in a separate report.

Similar work on *kanyin* was commenced during the year.

20. *Ventilation in the air-seasoning sheds*.—Data collected indicate results of some importance that will have to be applied in future when air-seasoning our timbers. A report will be drawn up when time permits.

21. *Seasonal variation of moisture content experiments*.—This experiment has been in progress sufficiently long enough to permit of useful deductions being drawn and was therefore brought to an end with the close of the year. The results are being analysed and will be written up in the form of a bulletin to be published later. The publication will include the results obtained for the companion tests on the moisture recovery of kiln samples.

22. One of the large kilns was prepared for Dr. Kapur's proposed visit to demonstrate his new method of kiln drying. The interior walls of the kiln were painted with a moisture proof paint to prevent loss of heat through the walls.

23. An Electric Moisture Meter was purchased from the Forest Research Institute, Dehra Dun. This instrument is designed and constructed at Dehra Dun. A series of tests with Burma woods will be carried out.

24. *Tests on the moisture content changes during shipment.*—A further attempt was made during the year to study the moisture changes in timber during shipment to England. The consignment consisted of *kanyin* flooring, made up into 4 bundles, each bundle having a different moisture content but the pieces in the individual bundles having the same moisture content. From the results recorded by Princez Rishborough, it appears that the technique is satisfactory, but the main object of the experiment was defeated by stowing the bundles among other material and not with the same kind of cargo. It is suggested that the experiment be repeated with bundles actually buried in similar material.

### (3) Timber strength testing.

25. A consignment of 4 logs of *thinrin* (*Millettia pendula*) was sent to the Forest Research Institute, Dehra Dun, during the year for tests under Project VIII—Plywood and Veneers.

### (4) Wood preservation.

26. In view of the failure of last year's experiment on the efficacy of different preservatives against white ant attack an attempt has been made this year to carry out the tests on better lines. Two species of timber have been used, *viz.*, *kanyin* (*Dipterocarpus* spp.) and *taungthuyet* (*Swintonia floribunda*) and no less than 11 preservative mixtures. One set of treated samples has been put down at the Government Timber Depot in September 1936 and a similar set in the grounds of the Pyinmana Forest School. The soil where the samples are put down was heavily infected with termites and as the samples were arranged to give the maximum amount of infection satisfactory results may be expected from the test. Both in Pyinmana and Rangoon stout fences were erected around the experimental plots.

27. *End-coating tests.*—A re-inspection was made during the year of all end-coated logs and controls in Kyetpyugan Depot. Definite results are not likely to be obtained until the logs have come through another hot weather but the conclusions arrived at from this inspection are:—

- (1) *Xylotez*—is by far the most suitable preparation for end-coating logs left in exposed conditions. Very little, if

any change was noted on logs treated with this preparation.

- (2) *Seekay Wax*—is of doubtful value as it appears to flake off when exposed to the weather. It also quickly comes out of deep cracks so that further splitting is not checked. Seekay wax possibly has some effect in preventing fresh splitting.
- (3) *Aluminium paint*—this paint did not appear to have any effect at all as it was all washed off during the rains.
- (4) *Xylotex G. 10* & *Seekay Wax* (solid) were also tested out in the kiln. It appears so far that there is little to choose between them. Both compounds stood up effectively to drying temperatures up to 160° F. Above this to 180° F. there was slight blistering and peeling in both cases. Further tests are being carried out.

(5) Minor forest produce.

28. *Lac*.—Samples of dry and wet *gyo* (*Schleichera trijuga*) lac from the Shan States were sent as usual to the Indian Lac Research Institute, Namkum, Bihar, for experimental work.

29. *Cutch*.—Information about supplies of cutch likely to be available during 1936-37 was collected and given to a firm dealing in cutch. A cutch conference was held at Minbu during the year which was attended by a representative of Messrs. Finlay, Fleming & Co., and Mr. A. R. Villar, Conservator of Forests.

30. At the request of Messrs. The Bombay Burmah Trading Corporation, Ltd., a short note on *Tung* oil (*Aleurites fordii*) cultivation in Burma was prepared and forwarded to this firm.

31. Further supplies of the bark and latex of *Letto-k-gyi* (*Holarrhena antidysenterica*) were sent to the Chemistry Department of the Rangoon University where research is being carried out on this product. An extract of this bark known as "Kurchine" is being used by doctors here in the treatment of dysentery.

32. Further enquiry was received from California regarding *Derris elliptica* root but in view of the fact that the Burma species of *Derris* were not found to have any material insecticidal value there was no object in pursuing the matter further.

33. At the instance of the Silviculturist, Maymyo, 2,000 seeds of *mahogany* (*Swietenia macrophylla*) were collected and sent to the Cantonment Executive Officer, Maymyo.

34. Other enquiries were received for the following:—

Timbers suitable for the manufacture of hobbins and shuttles—  
from India.

Timbers suitable for butter boxes—from Australia.

Substitutes for walnut—from the United Provinces.

Timbers suitable for ladies shoe heels—from Bombay.

Timbers suitable for chopping blocks—from the Rangoon  
Arsenal.

Timbers suitable for manufacture of hockey sticks—from a  
Rangoon firm.

Substitutes for boxwood for spinning rollers—from Ireland.

Burma mulberry logs (*Morus laevigata*)—from London.

Burma timbers for veneers and plywood—from New Zealand.

*Artocarpus hirsuta*—from Lahore.

*Necm* leaves—from a firm in Rangoon.

*Broussonettia papyrifera*—from a firm in Bombay.

Gums suitable for manufacture of chewing gums from  
America.

#### (6) Paper pulp.

35. During the year enquiries were made regarding the possibilities of utilizing *kalan* (*Melaleuca leucadendron*) as a pulp wood. It was, however, found that the tree was not sufficiently abundant to serve as a pulp wood source.

36. Information on the available supplies, method of manufacture, etc., of the paper mulberry bark (*Broussonettia papyrifera*) was furnished to a firm in Bombay who were interested in the manufacture of Shan paper.

37. An enquiry was received during the year regarding the yield of bamboo on different cutting rotations from the sample plots of the Tavoy River area. As the plots were laid down only in 1931, information of this sort is unfortunately not yet available.

#### (7) Tans.

38. Nothing to report under this head. There was an enquiry from a Rangoon firm for mangrove solid extract used by sole leather tanners. Enquiries made from likely Divisions revealed that this commodity is not available anywhere in commercial quantities.

## (8) Wood working.

39. Expenditure and receipts for the Timber Research Branch are given below:—

*Timber Research as a whole.*

| Year.                | Expenditure. | Receipts. | Difference. |
|----------------------|--------------|-----------|-------------|
|                      | Rs.          | Rs.       | Rs.         |
| 1935-36 . . . . .    | 90,762       | 38,997    | —51,765     |
| 1936-37 . . . . .    | 127,376*     | 40,409    | —86,967     |
| Difference . . . . . | +30,614      | +1,412    | +29,202     |

*Workshop unit only.*

|                      |        |        |        |
|----------------------|--------|--------|--------|
| 1935-36 . . . . .    | 47,259 | 38,997 | —8,262 |
| 1936-37 . . . . .    | 45,960 | 40,129 | —5,831 |
| Difference . . . . . | —1,299 | +1,132 | +2,431 |

\* Excludes capital expenditure of Rs. 2,161.

The increase in the expenditure is accounted for largely by the increase in purchase of logs to build up depleted stocks. Otherwise the figures remain stationary, indicating the continued necessity for economy.

40. The Government saw-mill remained closed throughout the year, for reasons of economy, but the machinery was periodically cleaned and greased.

41. Timber supplies were dealt with as in previous years, the logs being cut into fitches in Messrs. Foucars mill and subsequently into boards in the workshop frame-saw.

42. One thousand and forty-eight tons of hardwoods were purchased during the year, of which 864 tons were converted to fitches. The 864 tons produced 708 tons of fitches, with a conversion loss of 18.1 per cent. as compared with 12.8 per cent. last year. These conversion results exclude the recovery of small handle blanks from *pagas* and the supply of fuel to the kilns from unserviceable material. 494 tons of fitches were converted,

producing 440 tons of planks, with a loss of 10.9 per cent., which is considered satisfactory.

43. The proportion of timber used on furniture and on non-furniture work, compared with previous years, is as follows:—

|                         | Tons of timber used in the workshop for the year |            |            | Book value of timber |               |               |
|-------------------------|--|------------|------------|----------------------|---------------|---------------|
|                         | 1924-25.   | 1925-26.   | 1926-27.   | 1924-25.             | 1925-26.      | 1926-27.      |
|                         |  |            |            | Rs.                  | Rs.           | Rs.           |
| Furniture . . . . .     | 15   | 10         | 12         | 2,145                | 1,919         | 2,916         |
| Non-furniture . . . . . | 294  | 119        | 268        | 22,279               | 12,614        | 21,479        |
| <b>Total . . . . .</b>  | <b>309</b>                                       | <b>129</b> | <b>280</b> | <b>24,424</b>        | <b>14,533</b> | <b>24,395</b> |

Non-furniture woods include hammer and other tool handles, floor blocks, panellings, packing and other timber supplied.

44. Altogether 27 species were handled in the workshop. They are given below in order of descending merit as regards the amount of work done with them:—

Major attention:—

Industrial:—

*Yon* (*Anogeissus acuminata*).

*Panga* (*Terminalia chebula*).

*Pyinkado* (*Nydia dolabriformis*).

*Ma-u* (*Anthocephalus cadamba*).

*Haaw* (*Adina cordifolia*).

*Binga* (*Mitragyna diversifolia*).

*Yemane* (*Gmelina arborea*).

*Thitkado* (*Cedrela toona*).

*Taungthayrt* (*Sirintonia floribunda*).

*Kyilar* (*Shorea asamica*).

*Kyetgo* (*Vitex canescens*).

*Kanjin* (*Dipterocarpus alatus*).

*In* (*Dipterocarpus tuberculatus*).

*Thitmin* (*Podocarpus wallichianus*).

*Didu* (*Bombax insigne*).



## Furniture—

*Yinma* (*Chukrasia tabularis*).

*Kyana* (*Carapa moluccensis*).

*Padauk* (*Pterocarpus macrocarpus*).

*Taukkyan* (*Terminalia tomentosa*).

*Thinwin* (*Millettia pendula*).

*Maniawgn* (*Carallia lucida*).

*Sit* (*Albizzia procera*).

*Sandawa* (*Cordia fragrantissima*).

*Aukchinza-ni* (*Amoora wallichii*).

## Minor attention—

*Thitka* (*Pentace burmanica*).

*Thingan* (*Hopea odorata*).

*Petthan* (*Heterophragma adenophyllum*).

45. *Yon* continues to be in good demand and consumers appear to be satisfied with the standard of handles received. *Bagas* and other waste parts of *yon* not suitable for other purposes were converted into fencing material and tent pegs.

46. *Hnaw* and *binga* continue in favour for mounting blocks. Some *maniawga* was also sold for this purpose. *Panga* was again in demand for sucker rod protectors. Work on *ma-u* and *taungthayet* for boxes and packing cases was continued. Of the ornamental woods, *yinma*, *tauikkyan*, *kyana*, *thitkado* and *sit* were all in demand.

## (9) Miscellaneous.

## 1. Efforts to increase the sale of Burma timbers—

47. In accordance with the policy of the Timber Research Branch, more attention was paid during the year to research on teak, *in-kanyin*, *taungthayet* and *pyinkado*.

48. The present policy of the Branch with regard to the manufacture of *yon* handles is to carry on with the manufacture of about a lakh of handles per annum and at the same time build up stocks of seasoned *yon* plank that will permit manufacture at this rate for the next two years, yet leave sufficient seasoned stock to start off the industry, should it be taken up by private enterprise. Encouraging enquiries were received during the year from two firms in India who are in a position to take up the manufacture of *yon* handles.

49. Efforts are still being made to place teak poles for telegraph posts in the market. An enquiry was received during the year from the Burma Telegraph Department for supply of a small quantity of these poles. The question of supply is being gone into but the quantities required are too small to interest suppliers.

50. Owing to the high cost of the teak sleepers from the Northern Shan States referred to in paragraph 57 of the last year's report it was not possible to induce the Burma Railways to take them over.

51. The total number of *pyinkado* sleepers shipped on behalf of the North Western Railway, Karachi, during the year under report was 52,000 B. Gs. and 5,000 specials. A further order for 8,000 odd specials and 23,000 B. Gs. will be completed by 31st July 1937. These orders represent an export from Burma of some 6,000 tons of converted timber. The best quality sleepers came from the Pegu Yomas.

52. On behalf of the Eastern Group, Sleeper Pool, Calcutta, tenders for supply of considerable quantities of *pyinkado* sleepers were called for, but none of the offers made by the Burma suppliers were accepted as the prices were too high compared with sul.

53. Samples of cross-arms for telegraph poles according to the Post Office Engineering Department specification were made of *pyinkado*, *in-kanyin* and *padouk* and supplied to the Post Office Stores Department, London. A report on these samples was received after the close of the year stating that the samples were satisfactory and the three timbers concerned have now been added to the Post Office Department's specification.

54. Efforts were made during the year to market floor blocks of various Burma hardwoods, partly with the idea of consuming accumulated off-cuts at the Dépôt. Limited quantities were offered, but should any real demand materialise, it may be possible to interest exporters. Encouraging responses from firms in the United Kingdom, the Continent and India were received. Objections have been raised by the United Kingdom-manufacturers to the export of finished blocks and in view of these, efforts will be concentrated on the sale of half wroughts to the United Kingdom for the time being. The sale of floorings is an excellent method of getting our timbers known.

55. A firm in Germany interested in the box-shook trade was supplied with samples of *taungthayrt* (*Scintonia floribunda*) shocks and quotations for round logs c.i.f. Hamburg.

56. A small quantity of seasoned *yemane* (*Gmelina arborea*) was shipped to the Mathematical Instrument Officer, Calcutta, for the manufacture of Mathematical instruments.

57. A request was made by the Director, Imperial Institute, South Kensington, to fill one section of a museum case with Burma hardwood exhibits. Samples of trays, ash-trays, paper cutters, etc., mounted on a board, were supplied.

58. The usual display of Burma timbers was held at the Arts, Crafts and Industrial Exhibition held at Rangoon in February 1937. Arrangements were also made to display Burma hardwood furniture at the Illegu Rural Uplift Exhibition.

59. The survey of matchwoods of the Province referred to in paragraph 65 of the last year's report was completed during the year. The survey indicates that the supply and demand of matchwoods are about equal.

## 2. Comparative counts of beeholes made by the moth [*Xylutes* (*Duomitus*) *ceramica*] in teak logs from various localities—

60. A conference was held at Rangoon which was attended by Dr. C. F. C. Beeson, Forest Entomologist, Dehra Dun. The beehole borer problem was one of the items of entomological research discussed. Price degrade in teak timber due to beeholing was examined and seemed to justify extended expenditure on control measures of this pest. Dr. Beeson's recommendations on the biological and silvicultural measures of control of the beehole borer were accepted by the conference.

## 3. Departmental export of Burma timbers.

61. Three logs of *taukkyan* (*Terminalia tomentosa*) and 5 logs of *thinwin* (*Millettia pendula*) were exported to England for sale through the High Commissioner for India in London.

62. With the exception of considerable quantities of *yon* handles by the Timber Research Branch to the Indian Railways and round teak logs to the British Admiralty by the Depôt and Agency Division, no other exports of Burma timbers were made.

## 4. Timber passing—

63. Large quantities of *pyinkado* sleepers to the North Western Railway were passed during the year. The B. G. sleepers from Pegu Yoma forests supplied by Messrs. Bah Oh Teak and Hardwood Co., Ltd., Rangoon, were of excellent quality and the percentage of rejections was very small.

64. An order for supply of 1,920 tons Indian 1st class quality teak squares was placed by the North Western Railway with Messrs. The Bombay Burma Trading Corporation, Ltd. These squares are being graded by the Forest Economist in accordance with the *Seaman-Limaye Rules for the Grading of Teak squares*.

Further enquiries for the passing of teak squares for other Indian Railways on the *Seaman-Limaye Rules* were received.

65. A consignment of teak shingles under shipment to the Public Works Department at Port Blair by Messrs. The Bombay Burma Trading Corporation, Ltd., was inspected and certified during the year.

#### 5. Wood fuel for the Burma railways--

66. The scheme for supply of fuel to the Burma Railways continues to work quite satisfactorily. During the year efforts were made to amend the list of wood fuel species which the Burma Railways refuse to accept. About 21 species are excluded from the list of accepted fuel species of which at least 10 provide useful fuel. The Burma Railways approved of the inclusion of these 10 species for lighting up engines and for their Myituge Workshops but will not accept them for Locomotive use on the Moulmein-Ye line.

#### 6. Enquiries and liaison--

67. Miscellaneous enquiries were answered on timber, fuel, balsaes, lac, catch, tung oil, *Derris elliptica*, etc. The usual liaison was maintained with other specialists in Burma and at the Forest Research Institute, Dehra Dun. Also with the Forest Products Research Laboratory, Princes Risborough, England, Imperial Institute, London, Timber Advisory Officer, Railway and Defence Departments, Delhi, and the Timber Adviser to the High Commissioner for India, London. Acknowledgments are due for help from all these sources.

68. An extended tour of the principal Indian timber markets which included a visit to Dehra Dun was made by the writer on his return from leave during the cold weather. An extensive report on the tour was submitted to Government. The opportunities afforded of consultation with the various experts at Dehra Dun and elsewhere and of enquiry into trade conditions proved of great value.

69. Technical bulletins, journals and other publications were received from Britain, America, Australia, Africa, French-Indo China and the Philippines and elsewhere.

### 7. Ledger filing—

70. Ledger filing was carried out as usual. Matter of interest in the literature received which appeared likely to be important to Burma was ledger filed by extraction or reference.

At the request of the Forest Utilization Officer, Bengal, notes on our system of ledger filing were sent to him.

### CENTRAL PROVINCES.

Mr. Abdus Salam continued to hold charge of the Forest Utilisation Officer's post throughout the year. He attended the Forest Utilization Conference at Dehra Dun in March 1937.

#### (i) EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

*Depôt sales.*—The departmental sales of teak timber at Khirkiya, Timarni, Taku, Ellichpur, Akot and Ballarshah depôts were conducted by the Forest Utilization Officer as usual. The total amount of timber handled and the revenue realized at these depôts were:—

|       | From 1st April 1935 to<br>31st March 1936. |                     | From 1st April 1936 to<br>31st March 1937. |                     |
|-------|--|---------------------|--|---------------------|
|       | Quantity.                                  | Amount<br>realized. | Quantity.                                  | Amount<br>realized. |
|       | C.ft.                                      | Rs.                 | C.ft.                                      | Rs.                 |
| Total | 810,984                                    | 826,604             | 798,078                                    | 744,758             |

An experiment of collecting and remitting the sale proceeds through a *sahukar*, who was allowed a small commission, proved successful. Rs. 88,588-5 were thus collected and remitted on payment of a commission of Rs. 220-12.

*Lorry transport.*—The Allapilli Timber Transport Company transported from Allapilli to Ballarshah 219,695 c.ft. (258,145 c.ft.) of timber.

*Allapilli Saw Mill.*—Due to the break down of a pulley, the outturn of the mill fell from 85,494 c.ft. to 66,560 c.ft. Sufficient supplies of scantlings of the popular sizes were not always available.

*Scantlings.*—(a) *Teak.*—The total yield of teak scantlings in the Western Circle rose from 18,862 to 23,063 c.ft. which found a ready sale. Hand sawing of small butt ends and top pieces of teak trees was continued in Nimar and intensified in the Bori coupes of the Hoshangabad division. This enabled the coupes to be more fully exploited. Experimental hand sawing tried at Allapilli on a limited scale also proved successful.

(b) *Sales*.—Departmental sawing of scantlings made a further advance to 90,769 c.ft. and the material fetched better prices than last year.

*Sleepers*.—The first year of the three-year contract with the railways has been completed. Incidentally this was also the first year under the quota system. This system proved satisfactory as it afforded an opportunity of maintaining the organization throughout the year which resulted in greater yield of sleepers and scantlings. 40 tenders were submitted, out of which 14 were accepted. Sleeper prices remained stationary. The total value of sleepers supplied during the year amounted to Rs. 2,09,790. Demand for rejected sleepers continued good and all stocks were cleared at a slightly higher price than last year.

*Pit-props*.—Orders for pit-props were secured from Ballarshah and Panch Valley Collieries during the year and complied with. The standard of poles desired for pit-props is high and limits the quantities which can be supplied.

*Gun Carriage Factory, Jubulpore*.—The Forest Utilization Officer visited the factory twice and obtained an order for 1,000 c.ft. of sal logs and two orders for special size teak planks worth Rs. 1,290.

*Bamboo*.—The departmental bamboo operations were continued in Bilaspur. The revenue realised was Rs. 33,601 (Rs. 11,277).

*Charcoal*.—Demand for charcoal continued to be good and large quantities were manufactured in almost all the divisions situated along the main railway line. Efforts are being made to induce contractors to use the portable "Frikiln" devised at the Forest Research Institute, Dehra Dun.

#### *Various species.*

*Adina cordifolia*.—1,000 c.ft. of rough squared logs were sold on orders from the Ballarshah depot. Demand for this species continued on a limited scale.

*Terminalia tomentosa*.—775 c.ft. of logs were collected and sold by auction at Khirkiya, where there is a small demand for this timber in the round. Orders for rough squared logs to the extent of 9,500 c.ft. were undertaken and supplied from South Chanda. There is a steadily increasing demand for this timber.

*Oagrcinia dalbergioides*.—3,711 c.ft. of logs were collected at Talu depot and realized the very good price of Rs. 1.5 per c.ft. There is a good demand for this timber but unfortunately supplies are very limited.

*Bombax malabaricum*.—Owing to large supplies of light woods from Malabar, the Central Provinces *semal* has received a slight set back and the prices secured during the year were not as good as usual. Messrs. Bachhraj Jammalal & Co., of Wardha, are putting up a match factory at Chanda, where matches are to be made partly by hand and partly by machines. This is a local enterprise which Government is encouraging by the grant of 253 *semal* trees at a reduced royalty of Rs. 3-13 per tree against Rs. 7-10 obtained in the open market.

*Boswellia serrata*.—The last supply of this timber made to the Eastern Group for making coffins proved satisfactory, and a further order for 10 tons has been received. This species is making headway in the local markets as well. Hand-sawn planks are selling readily in increased quantity as they are proving a good and cheap substitute for teak planks.

*Cleistanthus collinus*.—Two orders for supply of poles were secured and complied with from Ballarshah. Further orders are being negotiated. If supplies can be arranged at reasonable rates, the poles of this species have a good future.

*Gardenia latifolia* and *Gardenia turgida*.—Samples were supplied from North Chanda, Nimar and Hoshangabad divisions to a firm in Navasari and to Messrs. Uberoi & Co., of Sialkot. Both these firms have reported favourably on the samples. The former placed an order for a wagon load which has been supplied from North Chanda. Negotiations to secure an order from the latter firm are in progress.

#### *Minor forest produce.*

*Lac*.—The quantity of lac collected increased in all divisions except Bilaspur, Balaghat and Hoshangabad. The T. N. prices remained practically unchanged except for a short period of two months at the beginning of the year, when a temporary improvement took place. The total amount of lac collected was 89 maunds as against 2,145 maunds in 1935-36.

*Rusa grass*.—Trade in this commodity is still dull and the revenue dropped to Rs. 2,100 (Rs. 3,166).

*Tendu leaves*.—The demand was very brisk and Rs. 63,322 were realised from sales, as against only Rs. 12,158 in the previous year.

*Kulu gum*.—Departmental collection was continued in Damoh and Saugor. Experiments are to be undertaken to ascertain the best method of tapping. Rs. 12,956 (Rs. 14,742) were realised from its sale. The demand was good and prices appreciated.

slightly. The decrease in revenue is due to smaller collections. The export to foreign markets from Bombay during the past three years has been:—

| Years.            | Amount.     |
|-------------------|-------------|
| 1924-25 . . . . . | 69,841 cwt. |
| 1925-26 . . . . . | 57,435 ..   |
| 1926-27 . . . . . | 72,820 ..   |

*Katha.*—The revenue from leases for manufacturing *katha* was Rs. 12,756 (Rs. 11,095).

*Paper pulp.*—The right to collect *sabai* (*Pollinidium binatum*) grass was leased out in several divisions.

*Harra.*—The prices appreciated and the demand was brisk. Revenue realised from this source amounted to Rs. 6,820 (Rs. 5,769).

#### (ii) MISCELLANEOUS.

*Railway freight concessions.*—The question of railway freights for bamboos was taken up with the Bengal Nagpur and the Great Indian Peninsula Railways, and reduced wagon rates were secured for consignments between certain stations on the Bengal Nagpur Railway.

*Porna Exhibition.*—The following exhibits were sent by the department:—

Baskets and mats from Chanda; *haldu* combs and satinwood tea trays from Seoni, solid bamboo walking sticks; wooden dolla and *chhind* mats from Chhindwara; and samples of lac and *kulu* gum from Damoh.

### MADRAS.

The Forest Utilization Officer's functions were revised consequent on the transfer of sales in the Government Timber Depôts to the respective districts, and he has been able to devote more of his time to other important works, namely, study of market conditions, research, and propaganda. He also continued to look after the organisation and supply of track and special sized sleepers to the Railways and timber to Government departments and other special markets.

#### 1. EXPERIMENTAL SLEEPERS.

These were inspected as usual. The results of the line tests have shown that the average life of untreated B. G. sleepers of *Eugenia gardneri* species is about five to six years.



(2) Test lengths of *Hardwickia binata* B. G. and M. G. sleepers supplied from the Upper Godavari division, and of *Terminalia tomentosa* (karimaradu) B. G. and M. G. sleepers supplied from the Wynad division have been opened and their first joint inspection will be due in 1937-38.

(3) *Bolted sleepers*.—The result of trial of 1,000 B. G. bolted sleepers laid in the Madras and Southern Mahratta line in 1931-32 are given below:—

| Species.         | Dates laid.  | Nos.  | Nos. renewed. | Nos. split at one end. | Percentage. | Nos. split both ends. | Percentage. | Nos. requiring renewal. | Percentage. |
|------------------|--|-------|---------------|------------------------|-------------|-----------------------|-------------|-------------------------|-------------|
| <i>Nayal</i> . . | 14th December 1931, 1st September 1932 and 6th April 1932. | 612   | Nil           | 113                    | 18.5        | 117                   | 19.0        | 32                      | 5.2         |
| <i>Kopea</i> . . | 1st September 1932 and 6th April 1932.                     | 280   | Nil           | 77                     | 27.5        | 60                    | 21.4        | 4                       | 1.4         |
| <i>Xylia</i> . . | 1st September 1932 and 10th September 1932.                | 108   | Nil           | 19                     | 17.6        | 36                    | 33.3        | ..                      | ..          |
|                  |  | 1,000 |               | 209                    |             | 222                   |             | 36                      |             |

The Chief Engineer, Madras and Southern Mahratta Railway, reported that bolting ends of sleepers have not appreciably prevented splitting.

(4) *Eugenia gardneri* sleepers.—13 B. G. creosoted sleepers sent by the Forest Economist, Dehra Dun, and laid in Bezwada district, on inspection by the District Engineer, Madras and Southern Mahratta Railway, in August 1936, showed that one sleeper was badly cracked, eight were badly split at ends, and the remaining four were in good condition.

## 2. WOOD PRESERVATION.

(i) The supply of line poles from Madura district for electric transmission and distribution lines after treatment with Ascu was suggested by the Timber Development Officer, Dehra Dun, during his visit to the Plantations in August 1936.

Messrs. Callenders Cable and Construction Company, Madras, who are the local agents for Ascu wood preservative have been informed of our rates for the supply of line poles for Ascu treatment, and their move on the matter is awaited.

In the meantime, strength tests of line poles are being arranged to be made at the Engineering College, Madras, and the Forest Research Institute, Dehra Dun.

(ii) Out of six Accu treated pieces sent from the Forest Research Institute, Dehra Dun, for experiment, 3 were planted at Solur, about 12 mls. from Coimbatore, and the remaining three at Gundalur, 20 miles from Ootacamund in February 1936. When they were taken out in August and October 1936 respectively, they were found to be in good condition.

(iii) *Alder plywood board treated with Accu*.—A sample piece of alder plywood board received from Messrs. Binny & Co., Madras, was treated with Accu in the Forest Research Institute, Dehra Dun. The board, brush-coated with Accu, was found after six months, sound and intact, while the untreated board was completely eaten up by white ants.

(iv) *Osmosis wood preservative*.—Messrs. Massey Ganz, Hackettall (India), Ltd., are the local agents for this preservative. They carried out an experiment with this preservative at Kodai-kanal by treating pine and blue gum poles with Osmosis paint with a view to utilize them as electrical posts. Samples of Osmosis treated wood were sent to the Forest Research Institute, Dehra Dun, for "graveyard" tests. The Utilization Officer, Dehra Dun, reported that there was no attack of any kind so far, but the pieces had been under test for only eight months and as this period included five months of cold weather when there is very little termite activity, it was too early to offer an opinion.

(v) *Nylotec G-39*.—This preservative was reported to be suitable to prevent splitting and cracking in timber. Messrs. Massey Ganz, Hackettall, Ltd., who are the local agents, sent samples of this material for test and it was sent to the Pollachi and Wynad depots for test. The result of trial with this preservative was not favourably reported on.

(vi) *End-coating tests. Petroleum asphalt mixed with crude oil and bitumen mixture*. Petroleum asphalt mixed with crude oil was suggested by Mr. Kamesam, the Timber Development Officer, Dehra Dun, for preventing end-splitting of sleepers. The head office of the Burma Shell Company, Delhi, who are the agents, in consultation with Mr. Kamesam standardised a suitable bitumen mixture for this purpose. Experiments with this mixture were carried out in the sleeper depots, and in one depot in which an inspection was made, it was found that the mixture appeared to be helpful in preventing and in controlling end-splits, but a definite opinion could not be formed till results of more treated sleepers are known.

(vii) *Sealuy wood preservative*.—This is another preservative coming into use to prevent end-splitting of timber. The Imperial

Chemical Industries, Rangoon, who have local agents, have sent samples of this preservative for test. It is being tried in Pollachi Depôt. This is said to be more effective than the molten Seekay wax tried by the Forest Economist, Rangoon.

### 3. STRENGTH TESTS—PALMYRA POLES.

To determine the suitability of palmyra poles for electrical lines, six palmyra posts from the Cuddapah North division were sent to the Forest Research Institute, Dehra Dun, for strength tests. The result of the tests is awaited.

### 4. PAPER PULP.

(1) Investigation into the possibility of utilizing *botha* grass (*Andropogon schoenanthus*) from Cuddapah forests for the manufacture of paper pulp was undertaken at the instance of the Working Plans Officer, Cuddapah. Preliminary tests by the Paper Expert at the Forest Research Institute showed that it was inferior to *sabai* grass, but it was also reported that it was likely it might be utilised, particularly in admixture with bamboo for the production of medium grade papers, provided it was made available to mills at cheap rates. Hence three tons of *botha* grass are being arranged to be despatched to the Forest Research Institute for large scale tests.

*Cochlospermum gossypium* wood.—The suitability of pulp from *Cochlospermum gossypium* for paper manufacture was suggested and the Forest Economist, Dehra Dun, was also interested in having it tested at the Forest Research Institute. He wanted to know before undertaking the test if the wood is available in large quantities and at economic rates in the forests of this Presidency. The Conservators have reported that this wood cannot be exploited in commercial quantities and at economic rates, and finally the question was dropped.

### 5. WOOD INDUSTRIES.

(i) *Aircraft wood*.—Owing to paucity of supplies of *Polyalthia fragrans* of the specification required for aircraft work, the matter had to be dropped.

(ii) *Shuttles*.—A supply of 200 blocks of *Mesua ferrea* from the Palghat division was made to Messrs. Patel & Co., Bombay,

for trials in the manufacture of bottles, etc. The firm has since reported that they are not suitable.

(iii) *Veneer and plywood*.—Information regarding supplies of Madras woods suitable for a contemplated veneer and plywood factory by a French firm was furnished to the Forest Economist, Dehra Dun, who forwarded the information to the firm.

(iv) *Picking sticks*.—A small quantity of *Grevia tiliaefolia* from the Wynad division was supplied to the Buckingham and Carnatic Co., Ltd., for use in the manufacture of picking-sticks.

#### G. COMMERCIAL ACTIVITIES.

(i) *Track sleepers*.—29,776 B. G. and 16,503 M. G. hardwood sleepers were supplied during the year to the South Indian Railway at Rs. 6 per B. G. and Rs. 2.12 per M. G. affording a total revenue of Rs. 2,24,039-4 to the Department.

(ii) *Teak special-size sleepers*.—23,511 teak special-size sleepers were supplied to the South Indian Railway during the year, valued at Rs. 2,47,271.

(iii) *Timber supply—Public Departments*.—The requirements of the Public Works Department and other timber consuming departments were mostly for sawn timber; the Electricity department, Mettur Dam, bought logs—869 c.ft. of teak and 467 c.ft. of *pillamarudu* were supplied to them. A small quantity of about 88 c.ft. of teak was also supplied to the Central Jail, Salem.

The marketing of sandalwood in foreign countries was investigated and some of the firms in England and America were informed of the oil contents of trunk and root classes, which were equal to Mysore sandalwood oil recognized in British and American pharmacopoeia. A firm in the United States of America and another in France evinced great interest in the information supplied and they were put in touch with our usual bulk purchasers in Bombay.

(iv) *Timber Market*.—The year opened quietly but soon afterwards prospects of a good business in rosewood were noticed and taken full advantage of. The railway tender for a large supply of indigenous teak gave the much desired upward trend to prices at the close of the year.

The rate for good quality teak and rosewood logs ranged from Re. 1-8 to Rs. 2.12 per c.ft. Oversea quality, rosewood logs (72"

and up in girth) realised Rs. 5 to Rs. 13 per c.ft. and a few of the rosewood logs fetched peak prices from Rs. 23 to Rs. 28 per c.ft. The demand for rosewood logs continued during the year. Other miscellaneous hardwood logs ranged from Re. 0-12 to Re. 1-8 per c.ft.

Apparently Japanese demand for red sanders wood declined during the year for the rates realised in the auctions in Cuddapah and Chittoor divisions were poor. From the exceptionally high prices of Rs. 10 to Rs. 27 per c.ft. fetched in the previous year, the highest rate obtained did not go more than Rs. 3-15 per c.ft. This is nothing unusual as with high prices consumers look round for substitutes. If a good substitute is found, the price of the original article has of necessity to come down, if it is to be marketed. Boom prices are poor foundations for calculations of future profits.

During the year it was also noticed that there was a foreign demand for root-wood of red sanders for its excellent dyeing properties.

(v) *Exhibition.*—The Utilization division participated in the annual Park Fair Exhibition held in December 1936. Our stalls attracted many visitors and many enquiries were received.

Samples of figured Gadavari teak, Wynaad laurel, red sanders (wavy grain) wood, lac and lac products, and a few important minor forest products were sent to the Poona Industrial Exhibition, Lord Reay Industrial Museum, Poona.

8. The Forest Utilization Officer attended the Utilization Conference held in March 1937 in Dehra Dun, and took the opportunity of acquainting himself with the latest developments in the various sections of the Utilization branch in the Forest Research Institute.

#### *Minor Forest Products.*

*Nux vomica.*—The demand for *Nux vomica* was mainly for export overseas. About 365 candies of Sriharikota stock collected departmentally were sold at Rs. 11-4 per candy as against Rs. 12-8 per candy realised in the previous year.

*Tans.*—The demand for indigenous tan barks of *Cassia auriculata* and *Cassia fistula* was reported to be below normal during the year excepting the last quarter when a slight increase was noticed on account of restricted import of wattle bark.

Prices continued to rule low till February 1937. For comparison, the prices of local and imported tan barks in the Madras market are detailed below :

| Mo. and Yr.              | Price per ton<br>of <i>Caesalpinia</i><br>at the lake. | Price per ton<br>of <i>Coccinia</i><br>fruit. | Price per<br>ton wattle<br>bark. |
|--------------------------|--|---|----------------------------------|
|                          | Rs.  | Rs.   | Rs.                              |
| April 1936 . . . . .     | 68 to 70   | 41 to 45                                      | 87 8 0                           |
| May 1936 . . . . .       | 72 to 75   | 50  | 87 8 0                           |
| June 1936 . . . . .      | 72 to 107  | 50 to 54                                      | 85 8 0                           |
| July 1936 . . . . .      | 77 to 109  | 45 to 54                                      | 90 0 0                           |
| August 1936 . . . . .    | 77 to 102  | 50 to 54                                      | 92 8 0                           |
| September 1936 . . . . . | 68 to 100  | 50 to 54                                      | 92 8 0                           |
| October 1936 . . . . .   | 77 to 101  | 45 to 50                                      | 95 0 0                           |
| November 1936 . . . . .  | 64 to 95   | 32 to 47                                      | 95 0 0                           |
| December 1936 . . . . .  | 61 to 92   | 41 to 50                                      | 97 0 0                           |
| January 1937 . . . . .   | 65 to 95   | 52  | 99 8 0                           |
| February 1937 . . . . .  | 82 to 121  | 68  | 115 0 0                          |
| March 1937 . . . . .     | 115 to 122   | 68 to 81                                      | 125 to 150                       |

*Tan bark—marketing of.*—An investigation into the suitable sizes and weights of packages for marketing the indigenous tan barks as attractively as foreign barks was made in consultation with the Director of Industries and the Superintendent, Leather Trades Institute, Madras. The Superintendent's recommendation to retain the present size of package but to standardize its weight to 250 lbs. was communicated to Conservators for transmission to District Forest Officers and their bark contractors for giving effect to it in due course.

*Wattle bark.*—Wattle bark has been found very useful in tanning hides. As its imports into Madras had considerably increased within the past ten years, the advisability of growing wattle in suitable areas in this Presidency has been examined. Localities reported as suitable for raising it in plantations are the Palais in Madura District and the Nilgiris. The matter is being pursued.

(ii) *Araram bark.*—As the annual yield of the local tan barks from Government lands and forests is far below the requirements

of the Madras tanners, Government have ordered the raising of plantations of *avaram* wherever possible and action is being taken thereon in suitable districts.

*Tangedu experimental plots.*—*Avaram* bark from the two year old coppice shoots in all the five experimental plots in Vizagapatam division was sent to the Leather Research Chemist, Madras, for analysis. The analytical result is awaited.

*Lac.*—Cultivation of lac was continued in Cumbum range, Madura District. The yield was disposed of locally in the Presidency as scraped lac (11,450 lbs.), as washed lac (2,987 lbs.), and the revenue realised therefrom was Rs. 2,950-15 as against Rs. 6,692 realised in the previous year. The fall in revenue is due to poor yield and to lower market rates. Scraped lac was sold at Rs. 16 and Rs. 15 per maund as against Rs. 18 and Rs. 16-8 per maund realised in the previous year; and washed lac at Rs. 25 and Rs. 20 per maund as against Rs. 30 during last year.

The supply of 650 lbs. of seed lac to the Superintendent of Prisons, Madras, was made at the agreed rate of Rs. 21-9 per maund f.o.r. Madras.

The fall in price of lac in the Calcutta market affected our prices also. But so long as the price of the natural lac continues to rule low it will not be easy for the numerous substitutes to oust it from industries where it has been valued for its intrinsic qualities. Its demand in future would remain assured.

A firm on the West Coast has started a wood polish business and purchased about 2,050 lbs. of washed lac from Cumbum range. Should the venture prove remunerative the firm would continue to get its requirements of grain lac from the department.

The lac produced in Salem North division is mainly converted into shellac and wood polish, and supplied to Jails and Borstal schools and to Messrs. Spencer & Co., Madras. The total quantity of wood polish supplied (i) to various Jails, is about 235 gallons, valued at Rs. 890-9; and (ii) to Messrs. Spencer & Co., is 110 gallons costing Rs. 456-8.

Attempts are being made to extend the sales to Public Works Departments, Railways, and the Indian Stores Department, New Delhi.

Test crops on an experimental basis were tried in Mudumalai range in the Nilgiris. Results so far have proved satisfactory.

*Fuel from Cuddapah division.*—In September 1935, the Madras and Southern Mahratta Railway granted a uniform rate of freight for transport of fuel from Cuddapah and Chittoor divisions to

Madras. This concession proved advantageous to Cuddapah North division which was farthest from Madras, and resulted in a marked increase in export of fuel from that division.

*Dye yielding plants.*—Root and bark specimens of *Morinda citrifolia*, *Leucaena maderaspatana* and *Sonneratia jehrisiya* were supplied to the Government School of Dyeing and Printing, Calcutta, to enable the Principal to show at the Lucknow Exhibition the dye yielding indigenous plants.

*Diri-diri for boiler compound.*—From the local tanning materials recommended to the Madras and Southern Mahratta Railway, for the preparation of boiler compound their Chemist, and Metallurgist selected *diri-diri* for trial and asked for a sample, which was arranged from Viragapattam. Finding it satisfactory, he took over the whole stock at a good rate of Rs. 12-8 per candy, while the local Madras rate was only about Rs. 7 a candy. Their requirements are estimated at about 3 to 4 tons annually.

## ORISSA.

### (A) UTILIZATION.

#### I.—GENERAL WORK AND ADMINISTRATION.

Owing to limited staff no organized utilisation work was done during the year.

#### II.—EXPERIMENTAL AND COMMERCIAL ACTIVITIES.

2. Consignments of laurel wood, consisting of 50 logs in all, were sold to the Timber Adviser to the High Commissioner for India, London.

1st consignment—for 54" and up mid girth at 3s. 9d.

72" and up mid girth at 4s. 9d.

2nd consignment—for 54" and up mid girth at 4s. 0d.

72" and up mid girth at 5s. 0d.

The timber was supplied from the Angul division.

Out of the 25 logs ordered under the first contract two were sent after the close of the year. On their arrival in London the broker informed the Timber Adviser to the High Commissioner for India that one of them was the finest example of figured laurel that he had ever seen, and that if it had been sent on consignment it would have fetched at least 25s. per c.ft.

In Barapahar division, work on "improving the Mahanadi Channel for floating purposes was continued. 17,830 bamboos were



floated down the river from Ramedega to Sambalpur ghat at a cost of Rs. 344, or Re. 1-15 per 100. The costs include carting from the forest to Ramedega. Experimental floating in minor rivers such as the Danta and Jira was also undertaken. It is stated that villagers and contractors evinced great interest in the experiments and were keen to start floating on their own next year.

Negotiations have taken place with the newly formed Orient Paper Mill Company for the grant of long term bamboo leases in Sambalpur and Barapahar divisions. The Company has already started work on the erection of their mill at Ib station, Sambalpur district.

A proposal to erect a seasoning kiln at Cuttack is under the consideration of Government. Cuttack is an important carpentry centre with more than a local reputation. The normal consumption of timber by carpentry firms in Cuttack exceeds that of the kiln—400 c.ft. per month—which it has been proposed to erect. If the Capital of Orissa is fixed at Cuttack, or its vicinity, there will be an increased demand for sawn timber. A private contractor has agreed to erect the kiln, provided Government gives a lead by agreeing to purchase seasoned timber required by the Public Works Department from him. It now merely remains to settle the terms on which the Public Works Department will take seasoned timber.

The Public Works Department has been asked to build Ascu treated wooden bridges in place of ferro-concrete structures, whenever the former are possible. It is satisfactory to note that for the next main road projects they have agreed to do so. In their estimates they have provided for wooden culverts and the purchase of an Ascu treatment plant.

### UNITED PROVINCES.

The province is still without a Utilisation Officer, but it is hoped that one will be appointed at the beginning of next working season.

A small experimental unit for Ascu treatment of fence posts, saplings and softwood sleepers was erected in the Haldwani division but was not in operation during the year. Delay occurred owing to the difficulty in obtaining Ascu at a suitable price.

The Hydro Electric Department was supplied with 1,679 sal sapwood *ballis*, 33' and 36' long, for use as electric transmission poles after treatment by the Ascu process.

Ten seers of *Pongamia glabra* bark were supplied to the Forest Research Institute to test the tannin contents.

Considerable progress has been made with the propagation of lac in the Jhansi division. 200 mounds of stick lac and 17 mounds of dust lac were sold at a net profit of Rs. 515. A new factory has also been made in Banda division.

An experiment has been started in Jhansi to determine the best method of tapping *Shorea robusta* (kharay) trees for gum.

A small consignment of *Anogeissus latifolia* timber was sent to the Forest Research Institute to test the suitability of this timber for tool handles.

*The Lucknow Exhibition*—An Industrial and Agricultural Exhibition was held in Lucknow from December 5, 1936, to February 24, 1937. With the collaboration of the Forest Research Institute the Forest Department put up a very interesting and instructive exhibit in this Exhibition. The Forestry Court was situated in attractive surroundings among trees and flower gardens. About the most important exhibit was the "Asan Cottage". This was a model double storied wooden house proof against earthquakes, storms, white ants, borers and fungus. It was constructed and erected by the Forest Research Institute. The house was built entirely of Asan treated *chir* pine timber with the exception of ply wood used for part of the inside panelling and part of the roof. One room was panelled in *sissu* ply wood and furnished with high class Indian wood furniture, both made at the Forest Research Institute. Another room was furnished with painted furniture made out of cheap Indian wood in modern designs. Other rooms contained various exhibits, such as a Moisture Meter electric instrument and a series of exhibits showing the method of paper manufacture.

There were also lecture and exhibit rooms containing a variety of exhibits lent by various institutions or firms. This room also had a display of nearly 200 band specimens of different Indian woods.

*The Erosion Model*.—This was a case containing two models, one representing a forest-clad hill-side with a permanent stream and a flourishing village and fields, the second was topographically almost an exact replica of the first but the hill-side was bare with no trees. The object of this model was to demonstrate how necessary the protection and maintenance of forests are for the continued well-being and prosperity of mankind, especially in the hills.

Other features of the Exhibition were the reading and rest room, the *katha* making demonstration, the *Tharu* hut, the wild life

pavilion, an air-seasoning stack, the Forest Research Institute portable charcoal kiln, the Ascu pressure plant erected by Messrs. The Callender's Cable and Construction Co., Ltd., and a laminated bowstring wooden forest bridge.

Some distance away from Forestry Court was a heavy traffic wooden bridge constructed of Ascu treated timber. This bridge was 16' wide and had a clear span of 48', capable of carrying a distributed live load of 35 tons. The Forestry Court was generally acknowledged to be one of the most attractive and instructive courts in the Lucknow Exhibition.

It is believed that as a result of the demonstrations and exhibits put up by the department not only has great stimulus been imparted to the use of timber for many purposes for which other materials are used at present but, what is more important, a large measure of success has been achieved in bringing home to the general public the tremendous value of the forests and the urgent necessity of preserving and improving them.

## APPENDIX 1.

### *List of Provincial Forest Publications of 1926-27 (including the Forest Research Institute Publications).*

#### ASSAM.

*Flora of Assam* by U. N. Karmali, P. G. Kargil, A. Das and G. S. Purkayastha, Volume I, Part II.

##### *Indian Forester—*

Three years in Garo hills, by R. N. D.

Forest plantation in Assam.

A short note on Simul plantations in Assam, by J. N. Das.

Sal natural regeneration in Assam, by A. J. W. Milroy (with a note by H. G. Champion).

#### BENGAL.

*Notes on Shinning in plantations*, by G. K. Hendray. (Bengal Forest Bulletin No. 1.)

##### *Indian Forester—*

A note on timber extraction in the Chittlaong hill tracts, Bengal, by R. I. Macpherson.

#### BIHAR.

##### *Indian Forester—*

Effect of forests on erosion, floods, climate and rainfall and on irrigation experiments. Summary of a lecture delivered by W. D. M. Warren.

The Bihar and Orissa forest staff at the Patna Exhibition, 1930, by W. D. M. Warren.

#### BURMA.

*Note on yon as a hammer handle wood*, a concise summary of the properties of yon, its availability, milling, seasoning costs, prices, etc. (Economic Series, Pamphlet No. 9.)

Some experiments on the control of bamboo shot hole borer *Dinoderus* spp. in bamboo damago, by D. J. Atkinson. (Burma Forest Bulletin No. 22.)

##### *Indian Forester—*

Pool camp athletic recreation, by A. Long.

Prize day at the Burma Forest School, Pyinawna.

A short survey of developments in the use of yon for tool handles, by M. N. Gallant.

Shweda Forest Division, Upper Burma, by F. G. Burgess.

Charcoal burning in the south Pegu forest division, by A. J. S. Butterwick.

#### CENTRAL PROVINCES.

##### *Indian Forester—*

Thinning intensity, by K. P. Sagarika.

Forest in the Central Provinces, by O. M. Harlow.

## MADRAS.

*Indian Forester—*

*Xylia xylocarpa* for sleepers, by E. K. Krishnan (with a note by Forest Economist).

A brass gauge for use in making teak stumps, by A. L. Griffith.

*Dendrocalamus strictus*—Intensive working, by J. A. Wilson.

The beginning of teak plantations in India, by M. V. Laurie.

## ORISSA.

*Indian Forester—*

Additional note on plantation of *Dalbergia sissoo* in Keonjhar State, by H. F. Moonoy.

Thinnings in coppice crops, by J. W. Nicholson (with a note by H. G. Champion)

## PUNJAB.

Note on some factors which have contributed to the early revision of recent working plans, by A. P. F. Hamilton and N. G. Pring (Punjab Forest Record, Volume I, No. 1).

Effect of forest in preventing floods—Punjab Forestry Notes, No. 1.

*Indian Forester—*

The problem of natural regeneration of silver fir (*Abies spectabilis*), by J. D. Mahondru.

The practical problem of the management of the Himalayan fir forests, by H. M. Glover.

The Hoshiarpur Siwaliks from the air, by H. M. Glover.

A forest fire caused by falling stones, by G. R. Henniker-Gotley (with a note by I. G. F.).

Result of blue pine lopping in Balsam State, Simla hills, by Pritam Dass (with a note by I. G. F.).

Thinnings in Simla division, by N. G. Pring.

Note on *Lantana camara* in the Simla hills, by N. G. Pring.

Afforestation of the Ridge at Delhi, by R. N. Parker.

Punjab erosion conference, by R. MacLagan Gorrie.

Root suckers of Semal, by L. B. Holland.

Tree lopping on a permanent basis, by R. MacLagan Gorrie.

Note on soil erosion in the Punjab, by R. MacLagan Gorrie.

## UNITED PROVINCES.

Approximate volume table for *haldu* (*Adina cordifolia*) by E. C. Mobbs. (U. P. Forest Leaflet No. 6.)

Resin industry in Kumaon compiled in the Kumaon Circle, by R. G. Marriott. (U. P. Forest Bulletin No. 9.)

U. P. Forest Pocket Book, by S. H. Howard, 4th edition, 1937.

Second Interim Report on the Makhidumpur *Usar* experiment (U. P. Forest Leaflet No. 8), by F. C. Ford Robertson.

Record of seeding of the common tree species in the U. P. (U. P. Forest Leaflet No. 7), by F. C. Ford Robertson.

## Indian Forestry—

- Seedling regeneration in B. I. 54, by F. A. Smythies.
- A note on regeneration in the Picea-Pinus forests, by W. A. Bailey.
- Notes on Gladiolus distribution, by R. O. Drummond.
- Seed natural regeneration experiments in the United Provinces, by E. C. Mohler.
- The Hailey national park, by F. A. Smythies.
- Parapunt-proof fencing, by E. C. Mohler.
- Village uplift and its connection with forestry, by K. D. Joshi.
- The United Provinces forest department (Cannings) forewider fund.
- Note on the results of afforestation of Jammu, Chamba and other ravines.
- The Forestry Court II. P. Agricultural and Industrial Exhibition, Lucknow, by D. Stewart.

## APPENDIX II.

*Statement showing rank, designation and address of Forest Officers employed exclusively on research work in the various Provinces during the year 1936-37.*

| Serial No. | Name.  | Designation.  | Address.    |
|------------|--|---|-------------|
| 1          | Mr. C. S. Purkayastha, Deputy Conservator of Forests.  | Held the combined post of Botanical Officer and Silviculturist, Assam, from 1st April 1936 to 1st November 1936.  | Shillong.   |
| 2          | Dr. N. L. Bor, Deputy Conservator of Forests.          | Held the combined post of Botanical Officer and Silviculturist, Assam, from 2nd November 1936 to 31st March 1937.   | Shillong.   |
| 3          | Mr. S. M. Deb, Extra Assistant Conservator of Forests. | Forest Utilisation Officer, Assam   | Gauhati.    |
| 4          | Mr. R. I. Macalpine, Deputy Conservator of Forests.    | Silviculturist, Bengal, from 1st April 1936 to 31st October 1936.   | Darjeeling. |
| 5          | Mr. C. K. Homfray, Deputy Conservator of Forests.      | Silviculturist, Bengal, from 1st November 1936 to 18th February 1937.   | Darjeeling. |
| 6          | Mr. S. J. Curtis, Deputy Conservator of Forests.       | Silviculturist, Bengal, from 19th February to 17th March 1937.  | Darjeeling. |
| 7          | Mr. J. C. Nath, Deputy Conservator of Forests.         | Silviculturist, Bengal, from 18th March 1937 to 31st March 1937.  | Darjeeling. |
| 8          | Mr. W. L. Hodge, Deputy Conservator of Forests.        | Forest Utilisation Officer, Bengal, from 1st April 1936 to 24th October 1936.   | Calcutta.   |
| 9          | Mr. O. T. Trigg, Deputy Conservator of Forests.        | Forest Utilisation Officer, Bengal, from 25th October 1936 to 31st March 1937.  | Calcutta.   |
| 10         | Mr. W. D. M. Warren, Deputy Conservator of Forests.    | Forest Research Officer, Bihar  | Ranchi.     |
| 11         | Mr. C. W. D. Kermode . . .                             | Silviculturist, Burma (throughout the year).  | Maymyo.     |
| 12         | Mr. L. J. Vernal . . .                                 | Forest Entomologist, Burma, (from 1st April 1936 to 9th January 1937).  | Maymyo.     |
| 13         | Mr. R. Unwin . . .                                     | Conservator of Forests, Working Plans Circle, in current charge of the post of Forest Entomologist, Burma, for the period from 10th to 22nd January 1937. | Maymyo.     |
| 14         | Mr. P. F. Garthwaite . . .                             | Forest Entomologist, Burma (from 23rd January 1937 to end of year).   | Maymyo.     |
| 15         | Mr. M. N. Gallant . . .                                | Forest Economist, Burma (from 1st April 1936 to 15th May 1936).   | Rangoon.    |
| 16         | Mr. H. A. Maxwell . . .                                | Forest Economist, Burma (from 15th May 1936 to 9th November 1936).  | Rangoon.    |
| 17         | Mr. M. N. Gallant . . .                                | Forest Economist, Burma (from 10th November 1936 to end of year).   | Rangoon.    |
| 18         | Mr. H. O. Watts, Deputy Conservator of Forests.        | Silviculturist, Central Provinces, from 1st April 1936 to 14th September 1936.  | Nagpur.     |
| 19         | Mr. H. O. B. Jollyo, Deputy Conservator of Forests.    | Silviculturist, Central Provinces, from 26th October 1936 to 3rd March 1937.  | Nagpur.     |

| Serial No. | Name.   | Designation.  | Address.    |
|------------|---|---|-------------|
| 21         | Mr. T. T. Subramaniam, Deputy Commissioner of Forests,          | Assistant, Central Provinces, from 1st March 1927 to 31st March 1927.                                   | Nagpur.     |
| 22         | Mr. A. S. Subramaniam, Extra Assistant Commissioner of Forests. | Education Officer, Central Provinces, (throughout 1927).  | Nagpur.     |
| 23         | Mr. A. L. Subramaniam, Deputy Commissioner of Forests.          | Assistant, Madras.  | Ootacamund. |
| 24         | Mr. M. Subramaniam, Extra Assistant Commissioner of Forests.    | Assistant, Madras.  | Ootacamund. |
| 25         | Mr. M. Subramaniam, Extra Assistant Commissioner of Forests.    | Forest Station Officer, Madras.   | Madras.     |
| 26         | Mr. J. W. Subramaniam, Assistant Commissioner of Forests.       | Assistant at the duties of Research and Working Plans Officer (throughout 1927) in addition to his own. | Amul.       |
| 27         | Mr. H. M. Subramaniam, Deputy Commissioner of Forests.          | Divisional Forest Officer, Silvicultural Research Division, Punjab.                                     | Lahore.     |
| 28         | Mr. I. H. Subramaniam, Extra Assistant Commissioner of Forests. | Attached Officer, Silvicultural Research Division, Punjab.  | Lahore.     |
| 29         | Mr. H. B. Subramaniam.  | Attached Officer, Silvicultural Research Division, Punjab.  | Lahore.     |
| 30         | Mr. P. C. Subramaniam, Deputy Commissioner of Forests.          | Assistant, United Provinces, (throughout 1927).   | Sahni Tal.  |
| 31         | Mr. M. S. Subramaniam, Extra Assistant Commissioner of Forests. | Assistant, Silvicultural, United Provinces.   | Sahni Tal.  |



## APPENDIX III.

*Publications of the Forest Research Institute, Dehra Dun,  
available for Sale.*

## SILVICULTURE SERIES.

## BULLETINS (Old Series).

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## BULLETINS.

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| *33. Note on an Enquiry by the Government of India into the Relation between Forests and Atmospheric and Soil Moisture in India, by M. Hill . . . . . | 1 0 0  |
| *41. Note on Weights of Seeds, by S. H. Howard, Revised by H. G. Champion . . . . .   | 0 8 0  |
| *45. Note on the Miscellaneous Forests of the Kumaon Bhabar, by E. A. Smythies . . . . .  | 1 0 0  |
| *46. Rate of Growth of Bengal Sal ( <i>Shorea robusta</i> ), I Quality, by S. H. Howard . . . . .   | 1 0 0  |
| *47. Volume Tables and Form Factors for Sal ( <i>Shorea robusta</i> ), by the same author . . . . .   | 0 6 0  |
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